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ADVANCED MATERIALS

Siemens To Double Megachip Production in 1990

90CW0159b Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 27 Feb 90 p 8

[Article: Mass-produced 4-Megabit Memory Chip Coming Soon From Regensburg]

[Text] Siemens AG, Berlin/Munich, intends to double production of their 1-megabit chip in the current year. According to the Siemens house organ, a million megachips per week were produced for the first time at the beginning of the year in both the Regensburg and Munich-Perlach production sites. The goal of doubling the previous year's 20 million chips is quite realistic. Siemens began the megaproject in 1984. At the end of 1987, series production of the dynamic 1-megabit read/write memory chip (DRAM) began.

According to Helmut Berger, director of mega production in Regensburg, yield and quality of the chips makes Siemens the world leader. Siemens' Semiconductor Branch is the only manufacturer outside of East Asia which supplies the market with large numbers of 1-megabit chips. Mounting of the chip, its installation in a plastic housing, is done increasingly in Malacca, Malaysia, because of costs.

Over DM 600 million have been invested so far in mega production in Regensburg alone, with 1,020 employees. An additional DM 60 million are expected in 1990. With this, mass production of the 4-megabit chip will get underway in Regensburg. About 80 percent of the 1-megabit production facilities can also be used for the 4-megabit chip. While 2.2 million components-functions are housed on barely half a square centimeter for the megabit chip, 8.6 million components have to be integrated for the 4-megabit chip.

At the Siemens chip pilot plant in Munich-Perlach, 4-megabit production has been underway since September 1989. As Siemens' Chairman of the Board Karlheinz Kaske explained at the end of January, without this success it would certainly not have been possible to come to an agreement with the American computer manufacturer IBM on the joint development of the 64-megabit chip.

FRG's Fraunhofer Materials Testing Center Described

90CW0159a Duesseldorf HANDELSBLATT in German 22 Feb 90 p 16

[Article: "Coatings Yield Completely New Materials: Fraunhofer Society: Silicate Research"]

Coatings, like those which the Fraunhofer Institute for Silicate Research (ISC) develops in Wurzburg and which lead to new materials, can now be tested in a "users' center." In this way, the institute will put special emphasis on promoting the transfer of research results.

Like a varnish, coatings with glass, ceramics and "ormocers" (these are complex inorganic-organic polymers) finish materials and improve mechanical, optical, electrical or chemical properties. ISC has already transferred technologies and coatings to industry. Examples of developments are scratch)resistant plastic eyeglass lenses, improved components in electrical engineering and in electronics, and the protection of historical glasses.

At present, research is underway for improving resistance to corrosion and UV light, for better resistance to scratching, abrasion and wiping, and for coating soft plastics which, with a hard surface, would be suitable for watch glasses, for covering indicator gauges in automobiles, and for protecting gift articles. Coating of soft alloys such as brass; coating of tin, aluminum or precious metals for protection against dirt; and coating of high-quality articles for daily use are also possible. In microelectronics, coatings improve the thermal and electrical properties of materials.

Based on its previous experiences, the ISC sees initial applications for innovative products in coating technology for mid-size industries. In order to speed up the transfer of developments, a users' center has been built. DM 12 million are planned for this purpose for five years, with the Free State of Bavaria being responsible for half this amount. The other half is to be financed through contributions from industry and in small part through the resources of the Fraunhofer Society.

In the center, interested industries will be trained in the use of coating technology and can work out individual solutions for themselves. The ISC will provide guidance up to project design, trial production and process development. In the center, various techniques such as dipping, spraying, wiping, glazing, spin coating or painting as well as hardening by heat or UV radiation can be demonstrated and tested. In addition, measurement of coating thickness, hardness testing and weather exposure tests can all be done in the center. A clean-air area is available for coating experiments. The user can also test all aspects of the technology thoroughly on the premises before he acquires it and uses it in his own plant.

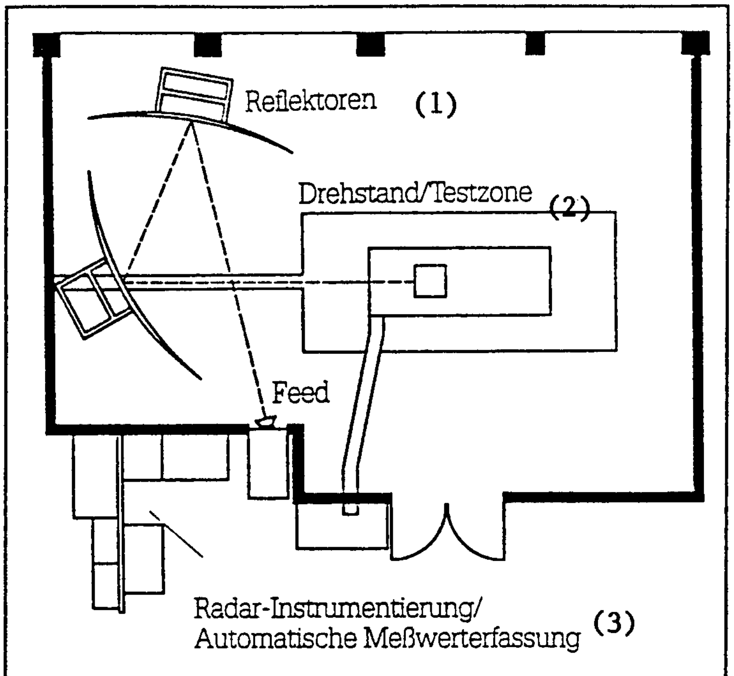
AEROSPACE, CIVIL AVIATION

New Radar Cross Section Test Facility in Use at Dornier

90CW0150B Stuttgart FLUG REVUE in German Feb 90 pp 91-92

[Article by K. Schwarz: "Radar Measuring Chamber at Dornier"]

[Text] **The suppression of radar reflections is difficult. Model measurements facilitate the work of aircraft designers. Dornier has activated a modern test chamber.**



Two curved reflectors concentrate the radar waves onto the test zone, which houses the rotating stand.
Key:—1. Reflectors—2. Rotating stand/test zone—3. Radar instrumentation/automatic recording of measurement values.

In the military area, as has also been recognized by the European aviation industry, there will hardly be any avionic instruments which are not oriented toward low radar detectability. Since the Americans, who are leaders in the Stealth sector, are not sharing their knowledge, firms in this country must work out their own know-how. In addition to the MBB Corp., therefore, Dornier has also installed an antenna and radar cross section measuring chamber. It is integrated in the new electronics center of the enterprise at Friedrichshafen and has been operating since the end of last year. The standards of the facility are similar to facilities of U.S. firms.

The "compact range" which is equipped with two parabolic reflectors uses the Inverse-Synthetic-Aperture System (ISAR) for purposes of acquiring two-dimensional radar images. In this procedure, the electromagnetic waves, radiated by the feed system, are bunched by two reflectors in such a manner that a radar distance field having good homogeneity of amplitude and phase is simulated in the test zone ("quiet zone").

The echo signal is concentrated in the feed system in reverse image via the reflectors. If the test object now moves on a high-precision rotating stand, the range and Doppler information can produce a very accurate radar image. The achievable resolution is higher, the higher the measuring width is and the greater the evaluated angle regions are. Bandwidths of several gigahertz for the resolutions of several centimeters are easily attainable, according to data provided by Dornier.

In order to achieve measuring results as free as possible of defects, the test chamber is carefully lined with sound-proofing devices. Depending on the frequencies, they result in a reflection attenuation of from 35 to more than 55 decibels. Currently, it is possible to operate within a frequency range of from 2 to 18 GHz; nevertheless, by adding supplemental implementation, it will be possible, in the future, to operate with measuring possibilities in the frequency band from 93 to 95 GHz.

The rotating stand can accommodate objects weighing a maximum of 100 kg—it has an angular accuracy of 0.003 degree. The test zone measures 1.6 x 2.4 meters. This is adequate for structural components or for small drones. However, aircraft have to be examined on a model scale, with appropriately adapted frequencies.

Cleverly designed software controls the entire facility and supports the work of service personnel through a menu program. The data flow can be worked up graphically by different methods. Frequently, retrograde dispersion centers are depicted in color, for example. It is also important to determine the radar cross section in dependence upon the frequency involved.

In addition to tasks in the Stealth area, the new facility is also suitable for measurements of antenna orientation characteristics or for radom measurements. This is not only of interest in the aviation and space area; also integrated vehicle antennas for mobile broadcasting can, for example, be tested.

The characteristics of the new radar cross section measuring chamber at Dornier are of interest to a broad circle of users. Its significance could increase over the coming years. In the German Aerospace Association (DASA), it will, in the opinion of the enterprise, thus contribute to improving international competitiveness.

Current, Future Stages of Hermes Shuttle Discussed

90CW0156B Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 14 Feb 90 p 8

[Article: "Hermes Shuttle Will Also Be Able to Dock with the Soviet Space Station Mir—Ejection Seats Planned as Rescue System: Technical Concept of European Aerospacecraft Hermes Takes Shape"]

[Text] Plans for manned European space travel in the next decade include, besides the high-thrust Ariane-5 and the Columbus orbital station, the small Hermes shuttle—technically the most difficult project—as well. After lengthy studies and substantial changes, the final concept for the Hermes design has now crystallized. The breakthrough was brought about by the abandonment of the original plans for the heavy, complicated rescue capsule. Instead of the capsule, the three Hermes astronauts—in the event of an emergency—will now be catapulted from the cabin by means of special ejection seats.

On the occasion of the 2nd Hermes Industry Day and a colloquium held in Munich, the managers of the European Space Agency gave an update view of the technical, organizational, and financial aspects of the planned spaceplane. Commencing from 1998, Hermes is to take men and materiel into earth orbit and regularly visit the European space station Columbus. Even an occasional docking with the Soviet orbital space station Mir is now planned.

Euro-shuttle Hermes consists of three structural elements, the actual spacecraft—a Delta-wing craft without tail planes, containing the astronauts' air-conditioned cabin and cargo room (33 cubic meters) sufficient for a maximum scientific payload of 3,000 kilograms; a supply module in the aft section tailored for current mission requirements, which before reentry separates and is jettisoned; and a vernier stage linked to the Ariane-5 rocket for insertion into earth orbit.

Hermes will be launched twice a year and will mostly be used to visit the Columbus station's man-tended free-flier laboratory, where the astronauts change test arrangements and undertake scientific experiments. Hermes will also visit the large international space station Freedom. Such missions can last 10 to 12 days. "The service life of the two planned Hermes orbiters will extend for 30 missions or about 15 years," Joerg Feutel-Bueechl, the ESA director for space transport systems explains.

The Hermes ejection seats now planned to rescue the 3-man crew will be operable from and during the launch up to about 24 kilometers in altitude, where, 84 seconds after lift-off, a speed of Mach 3 is reached. And during the critical landing maneuver the astronauts would be able to get out of a threatened Hermes from a height of about 30 kilometers. To be able to do this, the crew must wear specially "hardened" suits during take-off and landing, which will protect them against the sudden high pressure, the violent wind blast, the explosive charge itself, and the high-altitude vacuum. Included in the rescue gear are special survival packages for emergency astronaut ejections over land and sea as well as optical and radio direction-finding aids to facilitate their rapid detection.

Now that this basic question of the rescue system has been decided upon, the final outer shape of the small Euro-shuttle and the other important systems will be established in the coming months. It was long contested, for example, whether Hermes was to have a central vertical tail assembly (like the much larger American and Soviet shuttles) or two "winglets' at the sides of the Delta-wing tips, which, after extensive wind-tunnel tests, have finally proven to be the more favorable solution. The question of Hermes' heat shield has also been carefully examined. Now, after the most recent studies, it will consist of about 850 carbon tiles, which will absorb the high temperatures during reentry.

Meanwhile creating sections in the spacecraft proper, the droppable supply module, and installing the engine unit in the carrier rocket have proven to be correct decisions the Hermes' development. To be sure, several expensive components are lost after launching, but in compensation Hermes gains a great deal in mission flexibility since this adapter can be equipped for any flight with other systems, e.g., with a special coupling adapter for the Soviet Mir station. To do this, Hermes would have to be inserted in a special orbit inclined 52 degrees to the Equator, which, despite the higher fuel expenditure, would be possible. The US-European space station will only be inclined 28 degrees to the Equator.

Reliable calculations indicate that the development of Hermes to the year 1998 will cost about DM 9 billion, which will be raised from the 12 participating ESA countries on the basis of a carefully negotiated formula. The largest amount (43.5 percent) will be paid by France, the second largest amount by Germany, at 27 percent or DM 2.4 billion. Other contributing nations are Italy at 12 percent, Belgium at 5.8 percent, Spain at 4.5 percent, and seven other countries at smaller amounts. "Presently about 1,500 engineers are working on Hermes,

mostly at CNES, the French space agency. By 1992, more than 6,000 experts throughout Europe will be involved in some 300 enterprises and organizations," predicts J. J. Capart, Hermes Project Manager at ESA.

Because of the decision in favor of the ejection-seat rescue system, taken just recently, the entire Hermes

design must be revised and reviewed again. Consequently, the final development of the individual systems can only begin in mid 1991, even if the politicians of the participating ESA countries have given their approval. By then, the preparation of the extensive ground support components of the Hermes spaceplane must also be ready, as, for example, the launch facilities at Kourou in French Guiana, the maintenance facilities here in Europe, the ground station for mission control, the simulators and training facilities for the astronauts, as well as the selection of pilots and mission specialists.

Meanwhile, among proposals shelved were concepts advanced by prominent space experts for a so-called space capsule which, instead of Hermes, could be used to transport astronauts into orbit and back to earth. To be sure, just such capsules were used by the Americans earlier on and presently are still being used by the Soviets. They would be less expensive to develop and easier to handle in mission performance, but are far less flexible than a winged, maneuverable spaceplane. Such capsules are no longer even considered as a "lifeboats" for the space station crew members because Hermes could in an emergency also be used in rescue missions involving 6 to 8 astronauts.

On the German side, several space enterprises are participating in the building of the European spaceplane Hermes with interesting components, although the technically most interesting key items in the design remain reserved for France. Since now the rescue capsule, which originally was reserved for the German partner, has been dropped, the industrial assignments for the ESA countries participating in the Hermes project have to be allotted over again. In this process, the following assignments now present themselves for German companies:

MBB-Erno builds the propulsion system to be used for the final insertion into orbit and for deceleration before landing as well as for Hermes position control and effecting course changes. Dornier develops the spaceplane's life-support system with breathing-gas supply as well as temperature and humidity control; moreover Dornier is in overall charge of the space suit to be used for astronaut extravehicular activity. Finally, ANT will deliver the Hermes communications system as well as the data-processing systems used in the spaceplane and on the ground.

Ariane 5 Booster Technology Described

90CW0156A Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 16 Feb 90 p 8

[Article: "MAN Technologie Builds Ariane-5 Booster—Pressure Roller Process Unique for Europe in These Dimensions"]

[Text] Since the MAN Technologie company succeeded today in finalizing the entire order for the Ariane-5 booster housing in the amount of DM 390 million, the company seems assured of this space business until the year 1995. The first mockups will be delivered as early as March of this year. The first housings in flight configuration should follow by July 1991. The development of the components is to be completed in 1993, MAN Technologie reports. Following that, the first boosters for the three Ariane-5 test flights will be delivered in 1994-95.

As further reported, the pressure roller process is to be used in the production of each of seven individual rocket segments. For the dimensions involved, this will be unique in Europe and will result in cold-formed parts without welded seams. Thanks to the process, the wall thickness will be reduced from 40 to 8 millimeters, while the cylindrical segments will be lengthened from about one to 3.50 meters. In the terminal stage the solid-propellant rocket booster housings, including the upper and lower closures, will be 25 meters long and take about 230 tons of fuel apiece. Each of the boosters should impart a take-off thrust to Ariane of 600 tons. Beginning in 1996, the Ariane-5 will gradually replace the current Ariane-4, and in the year 2015, at the latest, become the "backbone of European space transport," according to MAN Technologie.

MAN Technologie had begun as early as 1986 with a preparatory program for the development of the booster housings. Two years later, in September 1988, the Augsburg Structural Fabrication Center, where the housings for the solid-propellant boosters would be produced on machines, specially developed for that purpose, was put into operation. But the company will not just be building the booster housings for Ariane-5, but the interface skirt and the high-pressure tanks for controlling the central stage's Vulcain engine and the solid-propellant booster's nozzles as well. The interface skirt is a load-conducting structure to take up the thrust forces of the solid-propellant rockets. The company, according to its own statements, is already one of the most important producers of engine components and structural parts for Ariane-4.

Aerospatiale's UNIPOLIS Composites Curing System

90CW0170B Paris LE QUOTIDIEN DE PARIS in French 2 Feb 90 p 21

[Article by H.T.:"Aerospatiale Builds the Biggest Microwave Oven in the World"]

The French aerospace company Aerospatiale is going to build an electron-gun "oven" for curing composite materials.

[Text] Composite materials find very many industrial applications. Like ceramics, they can replace certain light alloys to make knives with ever-sharp blades or scissors that cut anything but fingers. But these are just sidelines: composite materials are really serious. Aircraft airframes and rocket motors are made of them. The family includes Kevlar laminates and "carbon sandwiches," carbon fibers wrapped in resins and hardened.

They make possible the manufacture of structures that are both very sturdy and very light. The only problem lies in the fact that to provoke the chemical reaction that bonds the carbon layers,one needs to "heat the glue" (like hanging the type of adhesive wallpaper that has to be ironed in place). After assembly, the objects are placed in autoclaves, giant pressure-cookers, then heated to temperatures on the order of 120°C to 250°C. A complex operation that takes almost 24 hours per cycle.

Microwave Ovens ...

The trick discovered by the Aerospatiale engineers is to abandon "thermal molecular excitation." The basic principle resembles that behind microwave ovens, where cooking takes place not by indirectly exciting the molecules with heat, but by acting directly on them. In practice, it is a little more complicated. At the heart of the system is an electron gun, similar in principle to a particle accelerator. The electron flux projected on the piece being assembled, modifies the electron bonds between molecules, thus polymerizing the critical resins which serve as cement in the composites. The new system has been dubbed UNIPOLIS (UNIte de POLymerisation par Ionisation de Structures composites [Ionizing Polymerization Unit]). It boasts two main advantages. On one hand, the treatment is clearly faster than classic methods. On the other hand, using a "cold" process avoids expansion of the metal parts in a complex piece. This greatly facilitates creating alloy-quality bonds between metals and composites. Besides, by eliminating the chemical process, molecular activation allows the use of one-part resins: the absence of a hardener give them a longer life.

On the other hand, there are some inconveniences after all. The electron fluxes are dangerous to living organisms, even more so considering that the planned installation includes a 10 megaelectron- volt (MeV) accelerator. It will be able to process pieces 4 meters wide and 10 meters long. But to put it in operation in 1991 will require a sort of bunker with 3,500 cubic meters of concrete and doors weighing 300 metric tons each. Then, in a way, we will have the first industrial particle accelerator in the world in the suburbs of Bordeaux.

Aerospatiale Implements Computer Assisted Training

90CW0161A Paris L'USINE NOUVELLE in French 8 Feb 90 pp 22-23

[Article by Marc Nexon: "Aerospatiale: Better Training for Increased Production"]

[Text]

An ambitious computer-aided instruction program will begin at Aerospatiale in April. A way for the maker of the Airbus to increase production.

Intelligent computers used for training... At Aerospatiale, some ten engineers are working on a project that by 1994 will train 6,000 production employees in the "planes" division. The method to be used is ICAI (intelligent computer-aided instruction), a concept that has never been developed at such a large scale in a company. Estimated cost: 30 million francs. Aerospatiale is not making this investment out of a pure love of new technologies. Its problem is critical: By 1994, it must be capable of building 210 planes a year, compared to today's production of 100 a year. The order-books are overflowing: This year, for the Airbus AJ320 alone, the production rate must be increased from 6 to 10 units a month. The approaching arrival on the market of the AJ330-340 will continue to speed up production rates.

Along with this industrial commitment comes a human commitment: Work must be done more quickly, and differently. In order to work on today's "all-electric" planes, many mechanics must broaden their capabilities. The only solution is a strong dose of training, the keynote of which was announced by Toulouse production manager Jean Bgu: "A switch from small-scale to industrial-scale training."

So the ICAI program, called Digitef, is afoot. The feasibility study will be reviewed next month and soon thereafter the Saint-Martin unit at Toulouse will be equipped, followed by Saint-Eloi and Colomiers, then Nantes, Saint-Nazaire, and Maulte, in northern France.

The idea is to make a terminal available to assembly line and runway production personnel for consultation whenever needed to resolve a specific problem in a few minutes. Workers will also be able to go to terminals set up in "training islands" installed a few meters from their work stations and choose courses lasting ½ hour to a few hours, at their option.

"The strategy is to have only what we need," explains Bernard Malsallez, supervisor of the Digitef project. "In order for it to succeed, there must be a true dialogue between the worker and the console, so we plan to use graphics, sound, simulation, exercises, and video." The Orgue software, designed by a team from the Lyon CNRS (National Center for Scientific Research), is in keeping with this spirit. But the aim is even higher: Based on the employee's aptitudes and availability, the computer will be able to select a program for him. Paul-Sabatier university in Toulouse and Paris-VI university are developing these functions. "It's not just a training buffet," says Jimmy Sabourault, the head of CAI in the training division. "We are also guiding the individual." At the Saint-Martin unit, which is responsible for the finishing touches and testing of all planes, the project is being well-received. "We don't have time for outside training sessions," says a hydraulics specialist. "So if we can get it all right here, it's perfect." Another

explains, "We won't have to call the chief for every little problem. Provided they explain all the details."

Saint-Martin was not randomly selected to inaugurate Digitef. In effect, it represents the stage of production where lost time is highest. "An average of several tens of hours per plane," notes Patrick Tejedor, runway manager. "While aircraft is being flight-tested, my colleagues just have to wait. Not to mention certain clients who take delivery late. All this time could be spent on training." A source of satisfaction, too, for human resources management, which, admittedly, has reached a ceiling in the number of hours of training dispensed in conventional sessions (335,000 hours planned for this year at Toulouse compared to 140,000 in 1988). 75% of Aerospatiale personnel has received at least one week of training a year in the last three years, amounting to a 6% share of the total payroll.

For the group, it's no longer a question of increasing that share, but of finding new means of instruction. With Digitef, instructors should also benefit, by spending just 1/10 of the time in setting up their program. No more of those old mimeographs, either; real-time updates can be entered as soon as the engineering office announces them.

An estimate by Aerospatiale's Quality Management shows that the implementation of Digitef will permit a yearly savings of 10 to 15 million of the 80 million francs worth of "non-quality" incurred by production.

Beyond the borders of France, the promoters of Digitef are secretly hoping that Aerospatiale's European partners will one day join the program. Germany's MBB has already asked for French engineers to give a course. However, more than one technological secret will have to be revealed before a European training space can be created.

COMPUTERS

FRG Ministries To Adopt UNIX Operating System

90CW0157A Duesseldorf VDI NACHRICHTEN in German 2 Feb 90 p 14

[Article by M. Peter: "Bonn Ministries Decide for Open Computer System"]

[Text] In the future all FRG Ministries and other agencies will only introduce open computer systems, whose specifications correspond to the X/Open Group. By so doing, software can be easily interchanged between computers produced by different companies. The North Rhein Westphalian State Government has already accumulated positive results from this simplifying and cost-saving regulation.

The expenditure was considerable, but meanwhile operations have been paying off: Programmers can be employed more generally than before, costly user training can be minimized, and price pressure on the supplier market has increased. Following the "information-engineering declaration of independence" of April 1988, communications racks have become common in North Rhein Westphalian State offices. On 22 January, in Bonn, Klaus Rastetter of the Duesseldorf Ministry of the Interior announced: "After the UNIX directive, multistation computers may only be equipped with UNIX."

The government official responsible for data processing even harkens back another decade. As early as the 1970s, the State government made it mandatory to introduce open systems. In so doing, difficulties occurred during the transition period. "An architecture from a producer would have been simpler," Rastetter confesses. However, ultimately open systems would be more effective. And precisely that happened in the 1980s, when the ministries each installed their own equipment and decentralized data processing.

A considerable amount of convincing would be required for the practical implementation of the UNIX directive, but it finally proved to be the correct decision. And Rastetter declares the action of the State government to have been successful. One year after the declaration, two-thirds of the multistations had already converted to UNIX.

FRG Assumes Leading Role in European Community

Just as North Rhein Westphalia charged ahead with "sights wide open" within the Federal Republic, so too now the FRG is marching to the front in the European Community. The FRG was the first government to make an official binding recommendation that all ministries introduce exclusively open systems in the main frame computer shared resource system, based on the X/Open conformity instructions. Dirk Henz, Assistant Director of Bonn's Ministry of the Interior, points out the gentle pressure in the recommendation: "Whoever deviates from the recommendation must have very good justification." In government jargon this is a kind of reverse burden of proof.

Just like the leaders on the Rhein and in the Ruhr, Bonn hopes to profit from the cost-saving effects of open systems. Thus, Rainer Mantz of the FRG's Coordinating and Counciling Office for Information Technology is certain that it will have a favorable effect, especially in the case of postal departments personnel costs, system operators and programmers, but also users, who at best need be trained on it once. Mantz also sees savings on the procurement side. The Federal Government spends DM 700 million yearly on hard- and software.

Systems with the X/Open trademark were not just found in the various ministry offices. The German railroads and the Federal Bank had also decided in favor of X/Open systems. John Totman, marketing director of the X/Open Group, put the total yearly investment for open systems, after the recommendation, at DM 3.5

billion. This amount can certainly be much higher because of the "copycat" effect in other establishments and in the economy.

About 30 Computer Systems Have Received Certification Badges So Far

X/Open and its 35 associates have been able to attach its "certification badge" on some 30 systems so far. The turnover of X/Open-conforming systems should reach $ 4 billion. In Bonn in late January, Totman said that the turnover could double in 1990: "After the FRG's decision, we can reach that goal."

What is X/Open actually ? "Just as the European Community initiated the common internal market, X/Open can create a global market that will get technical obstacles out of the way." By this comparison Totman explained the strategy of the international consortium, in which computer and program producers as well as users like Lockheed, Michelin, or Daimler-Benz have joined together in a "standardization institute."

An internationally valid Common Applications Environment (CAE), independent of producers, is to enable and facilitate communications of existing and future computer systems. CAE is a collection of standards that X/Open has prepared and integrated into a consistent environment for application programs. Common Applications Environment establishes the interface between application programs and computer systems. In this way, all X/Open-conforming systems have the same run conditions and can be transmitted without change. The environment covers all important interfaces between system and application: from the operating system through data retention and programming language to user interfaces.

The "danger of splintering," according to Totman, can only be countered by means of compatible operating systems. The leading hard- and software producers have also seen this. In Totman's opinion, it is still the rather widespread incompatibility that obstructs growth potential, even as the needs of the users increase.

DEFENSE INDUSTRIES

Disarmament Affecting Military Technology

90CW0183 Paris L'USINE NOUVELLE in French 8 Mar 90 pp 80-81

[Article by Jean-Pierre Casamayou: "The Technologic Stakes of Disarmament"]

[Text] The agreements on weapons reduction will be the source of new technologies, particularly in the development of very precise observation systems and of protection equipment for the remaining weapons.

Europe will have to revise its defense technologies; that is one of the conclusions reached by the 13 defense ministers of the Independent European Program Group, who met several days ago in Scotland.

From the observation of disarmament agreement applications, to methods for developing new weapons systems, and even for sidestepping treaties, it is clear that one of the first results of agreements on weapon reductions will be an extraordinary technologic expansion.

The first efforts will consist of assuring that the disarmament is real, that is, verifying that treaty signers are following treaty clauses to the letter. To this end, various countries will increase their observation systems (optical and radar satellites, reconnaissance planes or drones) and will design a whole new range of detectors. The Open Skies agreement will offer an opportunity to accelerate the development of such systems. This treaty, which should be ratified in May, stipulates that planes equipped with a variety of electromagnetic (such as synthetic aperture radar) or optronic detectors will fly over the territory of signer nations. The basic technologies are already well known: infrared (IRCCD) or simple charge transfer (CCD) array detector cameras. The Americans have already calculated that this type of equipment will cost about 100 million francs per installation.

But this will be inadequate and more sophisticated systems will have to be devised, such as the Aurora hypersonic plane being studied by the American Army to replace its SR 71 Blackbird reconnaissance aircraft. Less advanced in this field, France is placing its bets on the Helios optical reconnaissance satellite. Thanks to the Spot program, the technologies have been perfected: the new HRV cameras and high speed magnetic recorders make it possible to obtain photos with a definition of the order of one meter (about ten meters with Spot). The next stage will see the development of a radar satellite which promises freedom from unfavorable weather conditions (clouds) in optical recordings of part of Europe. The radar will be a sideswept or synthetic aperture radar. The European satellite ERS 1 intended for oceanography will be a first experiment with this new technology; however, its precision (several tens of meters) fates it for civilian applications.

In any case, these optical and radar observation systems will require very sophisticated image processing, which MS2 I, a joint Matra and SEP subsidiary, already has on hand.

Increasingly Intelligent Weapons

At the same time, different countries will have to monitor their borders and their air space. This should be covered by a new generation of radars equipped with electronic sweep antennas. Hence the efforts being made by Thomson to develop hyperfrequency monolithic integrated circuits (MMIC) using gallium arsenide for the active modules of these radars.

Moreover, following the example set by the United States or Australia, France is also undertaking the study

of trans-horizon radars. These observation systems (a prototype of which, named Nostradamus and designed by DRET and ONERA, is being tested in the Dreux region) allow detection of movement beyond the range of conventional radars. Using meter wavelengths, the radar beam is aimed not directly at the object, but is reflected from high atmospheric layers. As a result, the beam illuminates the targets from the top, over the entire surface of a plane or ship. In parallel, the need to monitor about 6000 sites, such as equipment depots or military bases, has led to the idea of entrusting this task to automatic systems, such as optical, electromagnetic, or seismic detectors and sensors. These systems will be interconnected by high speed data links such as ACCS (Air-Control and Command System), currently used for radar.

All these systems will require new electronics as well as signal and data processing developments: faster computers and new computer architectures. This has given rise to research in very high speed integrated circuits (VHSIC), new semiconductors (GaAs), neoneural computers, or computer tools for programs that contain on the order of one million instructions.

These "force multipliers" will nevertheless rapidly prove to be insufficient. The military will always seek to obtain the same firepower with fewer weapons, which translates into greater equipment sophistication or into new developments for non-limited weapons ("Gorbi-compatible," according to the current jargon). Studies of "intelligent" weapons will therefore be encouraged. They will use such guidance technologies as infrared optical fiber (IRCCD) or millimeter wave for guided missiles or self-guided shells. Even conventional tank guns could find themselves transformed into electromagnetic cannons.

As another indirect result of disarmament, it will become necessary to save and protect the remaining weapons, as well as the personnel, whose training is very expensive. Consequently, everything concerned with countermeasures and with protection (optical countermeasures against infrared guided missiles, electronic countermeasures against active or semi-active missiles, as well as composite or active armor) will receive priority.

When the Military and Civilian Meet

Similarly, technologies that increase weapon "stealthiness" will also be in demand: new shapes that reflect radar waves poorly (warships or armored vehicles), wave-absorbing composite materials to cover planes or submarines. In addition, in order to save equipment and avoid losses during exercises, combat simulators will be used more widely, and will be made more realistic thanks to new display techniques such as Sogitec's GI 10000 or Thomson's Visa 4.

All of this research and development will have to be carried out in a framework of budget restrictions. It will thus be very difficult to devote large sums to strictly military research, which until now has served to encourage civilian research.

There is a danger that military technology will fade, become transformed, and further blend into civilian technologies. At this point, civilian and military research will become unified, the separation taking place at the application level. One of the stakes of disarmament therefore will be to maintain as wide a technologic base as possible so as to satisfy civilian and military needs.

Update on Franco-German Antitank Helicopter

Anatomy of the Tiger

90CW0171A Stuttgart FLUG REVUE in German Mar 90 pp 92-93

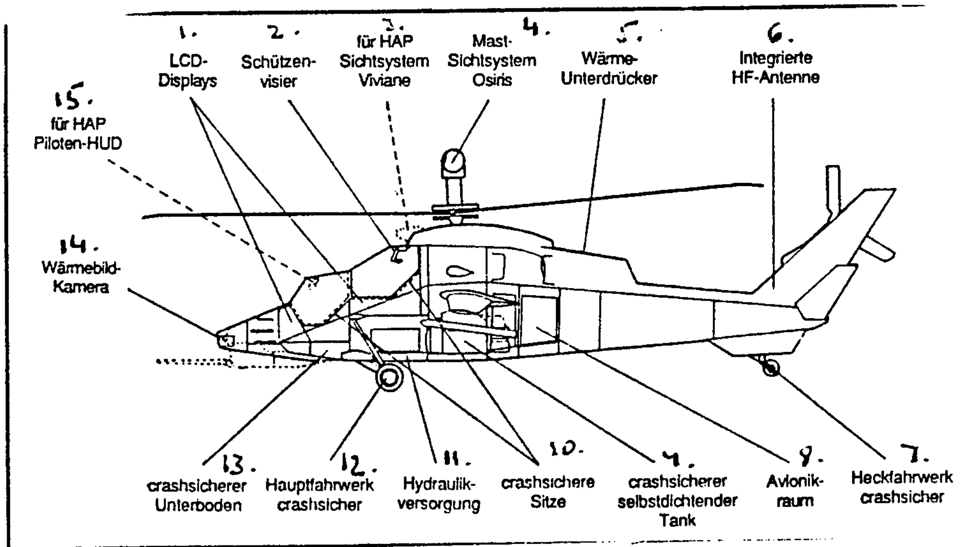
[Article by Helga L. Hillebrand: "Anatomy of the Tiger. Military Technology: Sub-systems for PAH-2 Selected."]

[Text] Sighting systems, cockpit equipment, navigation and many other details belong to the outfitting of the Franco-German antitank helicopter, PAH-2. Meanwhile, the business consortia have been selected and the orders for sub-systems have been issued.

The outer shell alone does not yet make a helicopter. Numerous sub-systems are required before the future antitank helicopter, PAH-2 Tiger, can be flown or steered. In the course of last year, the business consortia made their bids for the individual sub-systems. Since then, selections have been made and most of the contracts have been awarded.

With PAH-2, quite a bit was done for the safety of the crew. Already the landing gears—the PAH-2 has two main landing gears and one rear landing gear—are built for crash safety. That means that the shock-asorbing struts which, by the way, are not retractable, must withstand undamaged landings with a vertical velocity of up to six meters per second. While landing, the aircraft body must not touch the ground and the landing gear must not become permanently deformed. In the case of even harder landings, the floor structure makes impact and absorbs part of the energy. For this, the floor of the aircraft body is reinforced. In addition, the pilot seats are also made crash proof so that they can absorb the impact. Naturally, the fuel tank, which is located somewhere around mid-body, must also withstand these impact forces. Therefore, it is self-sealing so that sufficient fuel, for an additional 30 minutes of flight, is retained. This is particularly important when fired upon. In order to achieve as great a safety as possible even in such a situation, the seats are armor-plated against 7.62 and 12.7 mm ammunition in the back, the sides and on the underside.

The on-board supply of electricity is provided by two electric generators and two batteries. Each system is so designed that it must supply the entire power demand. The generators provide at any time 20 Kilowatt but are capable of expansion to 40 Kilowatt. At this time, there



Location of the important sub-systems in PAH-2/HAC and HAP (broken lines)

Key:—1. LCD displays—2. Protective visor—3. For the HAP, sight system Viviane—4. Mast sight system Osiris—5. Heat suppressor—6. Integrated HF-antenna—7. Rear landing gear, crashproof—8. Avionics space—9. Crashproof, self-sealing tank—10. Crashproof seats—11. Hydraulic supply—12. Main landing gear, crashproof—13. Crashproof underbelly—14. Heat sensitive camera—15. For HAP, pilot-HUD

is no de-icing provided for the main rotor but electric de-icing with the available generators would be possible later. The batteries provide for starting the first engine while on the ground, and also for radio reception and broadcast as long as the engines do not run.

Among the many sub-systems, the autonomous navigation is particularly interesting. It consists of two inertial navigation systems, a Doppler radar, the magnet sensor, flight data sensors and altimeter. In addition, a special low velocity device had been developed. Up until now, it was impossible to get reliable values when velocities were between zero and 40 km/h because the measurements are based on air pressure. This value was falsified through airflow caused by the rotor and was registered as too high. With the PAH-2, however, accurate data are required because these are used by the fire control system for guided weapons.

Liquid Crystal Display Screens in the Cockpit

For the inertial navigation system, the proposal of Sextant Avionique with the German partners, Teldix and MBB Dynamics, was selected. The triaxial laser gyro had been developed by the former Crouzet which merged with the avionics firm, Sextant Avionique. The Doppler-radar originated from Teldix, and MBB Dynamics supplied the velocity meter.

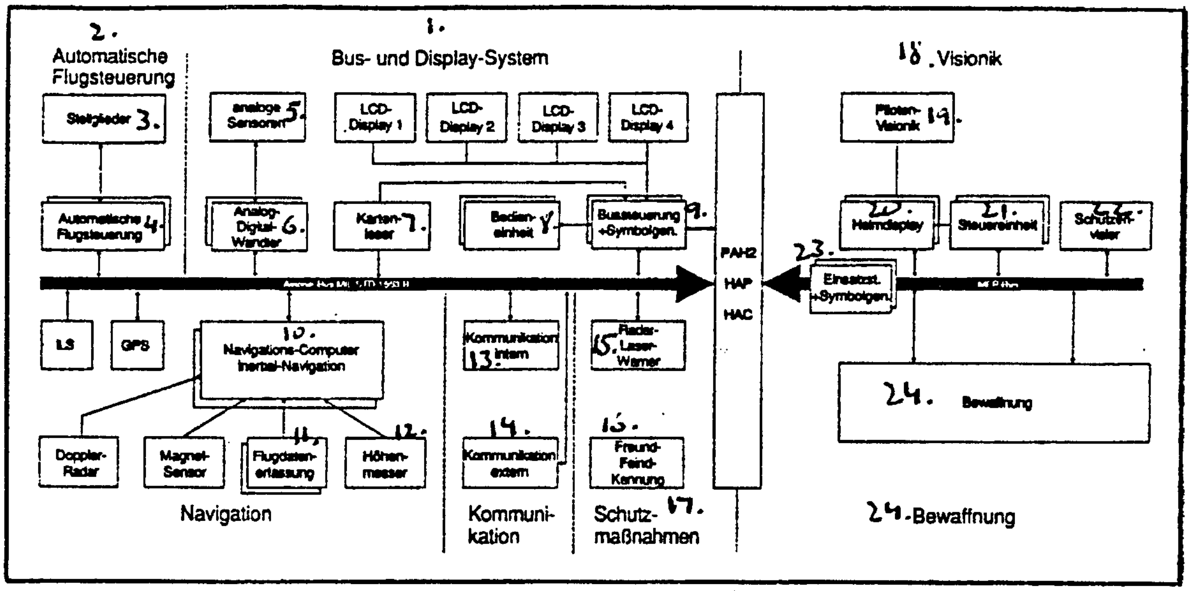
The navigation system is supplemented with a GPS-receiver for satellite supported navigation. Additionally, all French helicopters are provided with a receiver for the ILS instrument landing system which, however, is used only in peace time. Foregone is the future MLS.

The numerous antennae for communication and receivers are integrated into the structure wherever possible. Especially, the large high frequency antenna could be incorporated into the rear rotor mount.

The cockpit will be equipped with the technically most modern display screens. They are no longer CRTs working on the basis of the principle of cathode ray tubes but, for the first time, liquid crystal displays are to be employed. The four displays, two each for pilot and arms system officer, have a screen size of 6.25 by 6.25 centimeters and have full color capability. Their resolution with 512 dots per line and the same number of lines is so good that maps or the images of sight systems can be displayed on them. These multifunctional displays were developed by Sextant Avionique and VDO Luftfahrt.

With respect to the sight systems, there is a difference between the PAH-2/HAC and the second French version HAP. HAC and PAH-2 have pilot visionics built into the nose of the fuselage which has a heat sensitive camera. The field of vision is plus or minus 120 degrees horizontal and plus or minus 20 degrees vertical. The orientation of the heat sensitive camera is determined by the positioning of the pilot's head. Electromagnetic sensors measure the helmet position instead of the most often used light emitting diodes. With LEDs, problems would have arisen with light amplifiers in the cockpit.

Should the thermal image fail, the mast-mounted Osiris sighting system could also serve the same purpose. However, this is normally intended to serve as a gunner's sight. It is equipped with a thermal image camera and a TV camera, has a laser range finder and an electrooptic



Information flow in the Tiger: The bus systems collect data and transmit them

Key:—1. Bus and display system—2. Automatic flight control—3. Control flaps—4. Automatic flight control—5. Analog sensors—6. Analog digital converter—7. Card reader—8. Service unit—9. Bus control and symbol generator—10. Navigation computer, inertial navigation—11. Flight data acquisition—12. Altimeter—13. Internal communication—14. External communication—15. Radar-laser-monitor—16. Friend-foe recognition—17. Defensive measures—18. Visionics—19. Pilot visionics—20. Helmet display—21. Control unit—22. Gunner sight—23. Deployment station and symbol generator—24. Armament

orientation device to follow the flight path of the HOT-guided-missiles. The mast sight can be rotated 360 degrees. It is controlled through helmet positioning and through a small side stick next to the gunner.

In the HAC and PAH-2, pilot and gunner have a helmet display onto which the most important data are mirrored. In the HAP version this is not provided and the pilot receives a head-up-display instead. The HAP can also be distinguished through the sight system because, instead of the mast-mounted Osiris, it is provided with a Viviane, installed directly on the fuselage, which has a daylight channel in addition to the channels of the Osiris.

In order to be able to fly night missions even when the thermal picture system yields only very bad results, for example after a rain, it is currently being investigated whether a second night sight sensor based on light amplifier tubes should be integrated either into the helmet or the bow. The bus-system represents the Tiger's "circulatory system" consisting of two parts: one, the Avionik-bus according to MIL-STD 1553B, and the other, the MEP-bus for the armament and gunner visionics. But the brain of the Tiger is a computer unit, called bus control and symbol generator (BCSG), which is being developed jointly by Litef, VDO and Sextant Avionique. In this system, each individual piece of information from the sensors and instruments comes together, is processed for the pilot or the gunner and is passed on to every other sub-system. Only 25 to 30 percent of the capacity of the BCSG is used so that nothing is in the way of an expansion of the sensors and of the data processing on board, at some later date.

Meeting the Requirements

90CW0171A Stuttgart FLUG REVUE in German Mar 90 p 93

[Article by Karl Schwarz: "Meeting the Requirements. Modern Systems for Difficult Tasks"]

[Text] With the Tiger, the army flyers should get their first specially developed anti-tank helicopter after having had to be satisfied with the PAH-1, a version of the civilian BO 105, until now. The differences in performance are correspondingly clear. Greater velocity (over 250 km/h), greater additional load (eight instead of six guided weapons plus four Stingers against airborne targets) and a nearly doubled deployment time (2:50 hours) provide more punch.

Radar warning receivers, shielding of the hot engine exhaust gases and the mast sight provide protection against early discovery. The crew is protected by armored seats and cockpit panels, in case of a crash, landing gear and body absorb much energy thereby incresing the chances for survival.

A class difference also shows up in the areas of sensorics, avionics and cockpit equipment. Instead of only one optical sight for the gunner, there is now a mix of systems which should enable deployment also at night and in bad weather.

With respect to the sight systems, for example, the army flyers greatly valued a combination in order to balance out the physical limitations of individual instruments. TV and thermal imaging equipment together with the laser range finder are mounted in the mast sight—an important condition for low discoverability, and protection against direct anti-aircraft firing. Independently of the gunner, the pilot has his own FLIR for flying and also a helmet sight for deploying the Stinger.

For their own anti-tank version of the Tiger, the French use the same mission equipment all the way to the Mistral-air-air-guided missile. In the case of HAP, the variant planned for protective cover and general combat tasks, the gunner's sight system is mounted, to be sure, directly over the cockpit. In addition to TV/FLIR and laser, it also has an optic channel. In addition to the helmet sight, the pilot receives night vision goggles and a head-up-display. In the bow of the HAP, a movable 30 mm cannon is built in.

FACTORY AUTOMATION, ROBOTICS

FRG Manufacturing Requires Increased Precision

90CW0150A Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 12 Feb 90 p 10

[Article: "Ultraprecision Machines Are Also Not Good Enough for Future Products"]

[Text] Ultraprecision machines which are used to produce highly accurate components are, in view of their accuracy, representative of the limits of what is technically doable. Nevertheless, their accuracy is inadequate for the products of the future, whose requirements are higher than those of the present by a factor of 10. The limitations of current machines are based on the accuracies of their mechanical components. Further development is only possible through the combination of electronic control and regulating units, in the opinion of Prof Dr Eng Manfred Weck, one of the directors of the Laboratory for Machine Tools and Operating Science, as well as in the opinion of the Fraunhof Institute for Production Technology at the Advanced Technical School at Aachen, as it was presented to the Academy of Sciences at Duesseldorf.

In the area of production technology involved in complex elements, ultraprecision machines today are the most accurate machine types. It is only through the application of electronic measuring and regulating systems such as, for example, the use of laser interferometer path measuring systems and numerical control devices that made possible the processing of complex workpiece configurations using parabolic laser mirrors or video head drums. Numerous numerically controlled ultraprecision machines have been developed in the United States, in Japan, and in the Federal Republic, which can be controlled through processing controls operating within .01 of a micrometer of accuracy. The accuracy of such machines is currently limited by the mechanical components they use, which hardly permit an accuracy of less than 0.1 micrometer per 100 mm. For example, the accuracy requirements of entertainment electronics in the future lie far above those of today and the accuracy of the next generation of machines must also be appropriately higher.

Substantial improvements can only be achieved by joining mechanics with control technology. The constantly growing quality requirements of products and entirely new product groups have led to the fact that the technology of the most precise processing is also utilized in the Federal Republic. In the area of laser processing, for example, metallic mirrors whose form and surface quality must measure up to the highest quality requirements are used as beam sources as well as for beam guidance systems.

Other areas of use include highly precise workpieces in the computer industry and in entertainment electronics. Computer memory boards and video head drums are produced by these manufacturing processes.

The most important requirements levied on an ultraprecision machine used for processing of metal optics are maximum geometric accuracy of its machine components, a high degree of long-term stability, as well as the use of nonoscillating components. Existing machines are not suitable for use in maximum precision processing technologies because of their accuracy and the oscillations they produce. While machines for ultraprecision processing were being developed, the accuracy of processing machines was approaching that of measuring machines more and more. Thus, it can be said that fabrication accuracy is equal to measurement accuracy. This trend is becoming clear as a result of the constructive development of ultraprecision machines which ever more resemble measuring machines.

An ultraprecision machine which was constructed at the Fraunhof Institute for Production Technology at Aachen with the cooperation of Torsten Bispink, graduate engineer, has a machine bed made of natural granite for purposes of a high degree of long-term stability and the guidance surfaces for its air-mounted x-slide were processed with an accuracy of 1 micrometer per meter. The configuration of the machine bed as well as the positioning of the supports for the machine were so optimized that the processing motions of the slide masses cause only minimal deviations of the guide ways. In order to achieve the maximum possible self-frequencies in the slide system, the x-slide also consists of granite material which is lighter in comparison with steel.

The z-slide, which is mounted orthogonally on the x-slide, is a commercially available nail-mounted precision slide. This combination permits the application possibilities of various slide concepts to be compared in ultraprecision machines under realistic conditions. The slide drive must be in a position of being able to accomplish both the smallest reproducible processing steps of 10

nanometers as well as extremely slow uniform advance feed motions of 0.1 to 5 mm per minute.

That is why, following extensive comparisons, the friction roller principle was selected, in which a steel wheel of 30-mm diameter drives a hardened substance which is firmly connected with the slide. The numerical control system facilitates the execution of comprehensive processing movements. A highly accurate laser interferometer path measuring system serves as a slide position feedback system which, in conjunction with the controls, possesses a resolution of 0.01 micrometer.

The most important component in the production of highly reflecting surfaces, in addition to the natural diamond tool, is a highly accurate main spindle unit. With the aid of computer programs, an air-mounted double-spherical spindle was laid out in the design phase in such a way that, under operating conditions of approximately 0.5 newton, spindle deviations of less than 10 nanometers result.

Before the spindle drive, numerous clutch systems were investigated such as, for example, contactless magnetic clutches and flexible bellows clutches. A flat belt drive proved to be the most suitable solution and transmits particularly few influences of the drive motor to the spindle. For purposes of accepting workpieces without deformation, workpieces are held in a vacuum lining which attaches the rear of the test pieces by vacuum action to its grooved face.

The processing accuracy of ultraprecision machines is dependent upon many influence factors. In many countries, there is agreement that further increases in accuracy are only achievable by connecting mechanics with intelligent control units. An example shows how the combination of mechanics and high-speed electronic control is instrumental in the possibility of producing highly complicated workpieces: the constantly growing number of requirements levied upon the laser and its applications in fabrication facilities places special requirements upon laser optics.

Requirements for laser structures suitable to perform hardening tasks or to transmit or form beams leads to an increasing demand for optics having special surface characteristics. With the development of new stable or unstable laser resonators, requirements levied upon surface formation pertaining to the utilized optics are also growing. In the future, a nontoroidal form of mirror surface will be needed, which is difficult to fabricate. While flat or spherical optics are currently fabricable in adequate qualities by turning or milling, the fabrication of nontoroidal surface forms is currently not possible or only possible at limited qualities and at high equipment-technical expenditure.

Currently, at the Fraunhof Institute for Production Technology, a processing unit is being constructed which permits the fabrication of such complex laser mirrors. A toolholder which is controllable in the micrometer range is mounted on the x-slide of an ultraprecision lathe. With the aid of parallelogram control, the tool is moved to the workpiece within the range of the smallest approach motions.

The approach motions of the prestressed piezoquartz is recorded by an expansion measuring strip, the signal from which is fed to the position-regulating circuit. The entire unit is settable in all three rotating axes for purposes of altering the angle of the tool. For purposes of adjusting the height of the cutting edge, the eccentric housing can be rotated.

With the aid of this unit and a specially developed piezoamplifier, it is possible to move the tool with a control frequency of up to 5 kHz. Currently, minimum oscillation amplitudes of 0.1 micrometer and maximum oscillation amplitudes of 7 micrometers are possible in this frequency range. The unit has already been used to perform the first processing experiments.

LASERS, SENSORS, OPTICS

Interim Report of EC EUROLASER Program Published

90MI0129 Stuttgart LASER UND OPTOELEKTRONIK in German Feb 90 pp 59-61

[Text] EUROLASER (EU 6) is one of the first 10 EUREKA [European Research Coordination Agency] projects announced at the second conference of EUREKA ministers, held on 6 November 1985. It is one of the long-term strategic framework projects characterized by ambitious, far-reaching assignments, complex organizational structures, relatively high costs, and protracted schedules. The EUROLASER framework project currently involves nine subprojects and a proposed project.

EUROLASER's primary goal is to make laser technology, particularly high performance lasers and their advanced applications, accessible to European users. This ambitious objective will be achieved in two stages, a "definition phase" and an "implementation phase." During the EUROLASER (EU 6) definition phase, which lasted over 1986 and 1987, feasibility studies were first carried out on the approaches to be adopted in solving technical problems.

Requirements were then defined and the organizational structures necessary for international cooperation created. Priority was given to research directed toward the development of high performance industrial laser systems and their application in materials processing in the following areas:

- CO_2 laser systems in the 10 to 100-kW output range;
- Solid-state laser systems in the one to 5-kW beam range;
- Excimer laser systems with outputs up to 10 kW.

Other areas of interest not studied in detail in the definition phase include:

- CO lasers with a beam output up to five kW;
- Free-electron lasers (FEL);
- Other laser systems for industrial and medical applications.

The EUROLASER definition phase produced a large number of individual findings regarding beam sources, system concepts, applications, and market potential for high performance lasers. Detailed and summary reports were published on the CO_2, solid-state, and excimer lasers of current industrial relevance. The reports assessed their technical development potential and possible markets up to the year 2000.

The main findings that emerged in the definition phase are as follows:

- Comparisons with developments in high performance lasers in the United States and particularly in Japan show an urgent need for R&D work in Europe.
- The planned EUROLASER projects entail high technical and scientific risks. They must be organized on a long-term basis and they require international cooperation.

EUROLASER has developed throughout Europe into a family of nine projects and one proposed project (see table 1). The EUROLASER projects and associated projects, some of which were already underway during the definition phase, are coordinated under the EU 6 framework project. There are at least seven other EUREKA projects on laser applications being carried out independently of EUROLASER.

Table 1: Outline of EUREKA Laser Projects, Total Funding, and Share Provided by the FRG

Outline of EUREKA Laser Projects		Total Funding	FRG Share
EUROLASER Framework Project	EU 6 EUROLASER	19.9 Million ECU	4.88
CO_2 Laser Projects	EU 83 EUROLASER—25-kW CO_2 Laser Cell	24.4 Million ECU	0.02
	EU 155 Joint Project on Laser Applications	4.5 Million ECU	2.9
	EU 180 EUROLASER—10-kW CO_2 Laser Modules and Related Systems	43 Million ECU	
EU 194 EUROLASER—Industrial Applications for High Performance Lasers	17.3 Million ECU	3.45	
	EU 204 Laser Station for Surface Processing	18 Million ECU	4.24
Solid-State Laser Projects	EU 226 EUROLASER—High Performance Solid-State Lasers	19.1 Million ECU	7.7
	EU 249 Advanced Production Technologies with Solid-State Lasers	19.9 Million ECU	2.2
Excimer Laser Projects	EU 205 EUROLASER—High Performance Excimer Lasers	17.4 Million ECU	10.1
	EU 213 EUROLASER - HIPLUSE Excimer Laser Project	20.8 Million ECU	
CO Laser Project	EU 113 Development of an Industrial Carbon Monoxide Laser System	1.8 Million ECU	0.28

BMFT Funding

The FRG government sees research and development in selected areas of laser technology as an important part of technological cooperation in Europe. The EUROLASER projects forming part of the EUREKA program thus have high priority, and FRG EUROLASER subprojects are eligible for public funding under the "Laser Research and Technology" program.

FRG participants are involved in a total of nine EUREKA laser projects (seven EUROLASER, and two associated projects). The BMFT [FRG Ministry of Research and Technology] is subsidizing subprojects within the EU 6, EU 113, EU 194, EU 204, EU 205, and EU 226 projects. FRG work on project EU 155 is being subsidized by the Land government of Baden-Wuerttemberg. Projects within EU 83 and EU 249 are being carried out without FRG funding (see table 2).

Table 2: List of German Partners, Projects, and Funding (according to BMFT information)

List of German Partners		Projects	Funding in DM millions
Industrial Partners	Siemens AG	EU6, EU205	5.46
	Rofin-Sinar-Laser	EU6, EU204, EU226	3.15
	Friedrich Krupp AG	EU204	1.05
	Leybold AG	EU6, EU226	1.02
	Schott Glass Works	EU6, EU226	0.91
	W.C. Heraeus	EU6, EU226	0.73
	Lambda Physik	EU6, EU205	4.87
	Carl Haas Lasertechnik	EU6, EU226	2.09
	Laseroptik	EU6, EU226	0.52
	Spindler & Hoyer	EU226	0.45
			Total 20.25
Universities	Aachen Technical University	EU194	1.51
	University of Erlangen-Nuernberg	EU205	0.72
	University of Stuttgart	EU6, EU113, EU205	0.7
	Berlin Technical University	EU226	0.31
	University of Heidelberg	EU205	0.27
			Total 3.51
Research Institutes	BIAS Applied Radiation Technology R&D Laboratory, Bremen	EU6, 194, 204, 205	4.68
	Fraunhofer Institute for Laser Technology, Aachen	EU6, 194, 205, 205 [as published]	4.31
	Fraunhofer Institute for Production Engineering, Aachen	EU6, EU194	2.14
	Laser Center, Hannover	EU205, EU226	1.34
	Solid-State Laser Institute, Berlin	EUEU226 [as published]	0.95
	German Aerospace Research Facility, Stuttgart	EU6, EU113	0.64
	Battelle Institute, Frankfurt	EU6, EU205	0.44
			Total 14.50

During the EUROLASER definition phase, the BMFT subsidized a total of 38 EU 6 subprojects for a relatively low sum (6.2 million Deutsche marks [DM]). With few exceptions, the various implementation phase projects began in 1988. The BMFT is providing substantial funding (DM33.2 million) for a total of 32 subprojects within five EUREKA projects. The addition of some further laser application projects is still in the planning stage. Funding is being concentrated primarily on EUROLASER projects EU 205 (excimer lasers) and EU 226 (solid-state lasers), which have 11 and 12 FRG subprojects, respectively. Subprojects within EU 194 (applications) and three subprojects within EU 204 (surface processing station) are also being subsidized. Two subprojects within EU 113 (CO lasers) that will study application potential have been granted approval.

The federal minister of research and technology has earmarked approximately DM340 million for the overall laser research and technology program between 1987 and 1993. Up to November 1989, the BMFT had allocated a total of DM39.4 million out of these funds for FRG participation in EUROLASER projects. The medium-term budget works on the assumption that EUROLASER projects will require a further DM50 million by the end of 1993. This means that every year more than 25 percent of the funds allocated to the BMFT laser technology and research program are spent on EUREKA projects (see figure 1).

The EUREKA framework conditions refer to auxiliary measures that can be introduced at the request of the project partners as an important means whereby the governments of participating countries can, and will, provide political support for EUREKA projects. Measures explicitly named in the Hannover declaration include:

- The drafting of joint industrial standards;
- The removal of technical trade barriers;
- The widening of eligibility to participate in public procurement tenders.

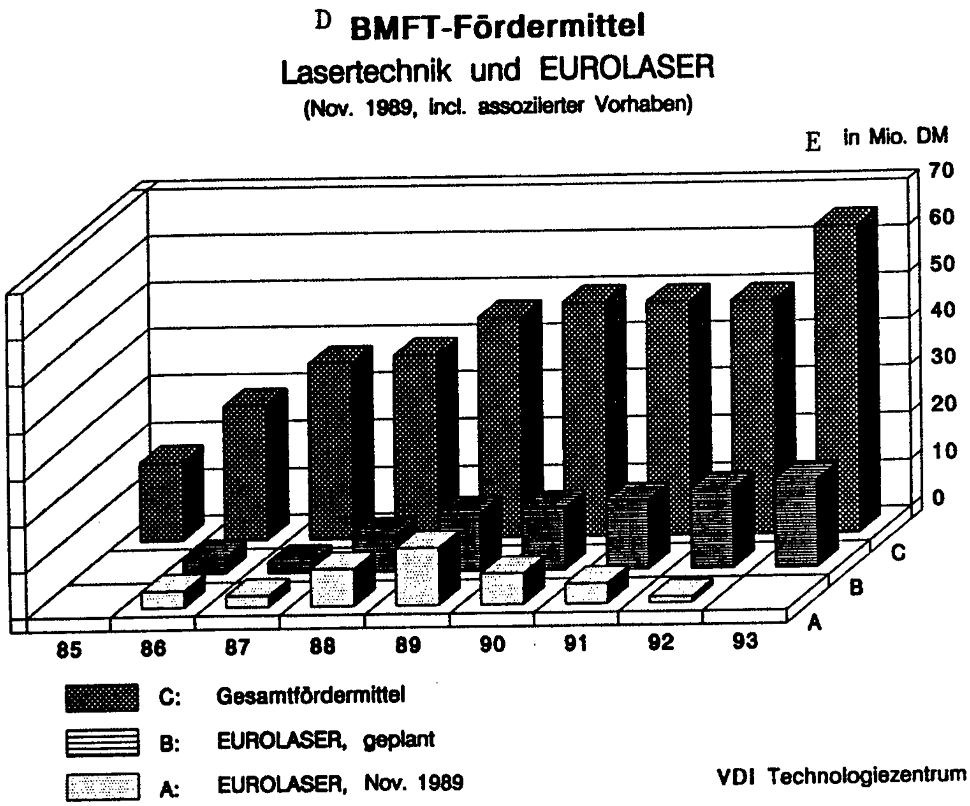


Bild 1 Gesamtes Fördervolumen des BMFTs für Lasertechnik und EUROLASER-Programm

Figure 1: Overall BMFT Funding for Laser Technology and EUROLASER Program

Key: A. EUROLASER, November 1989 B. EUROLASER, planned C. Overall funding D. BMFT Funding, Laser Technology and EUROLASER (as of November 1989, including associated projects) E. In DM millions

Initial Results of the Implementation Phase

The implementation phase projects are all still at a very early stage. After the joint projects have been underway for up to one and a half years, many are naturally still being set up or finding their bearings. At this stage therefore, only initial, indicative results requiring confirmation by further research are available.

In Project EU 205 a number of important steps forward have been made toward the development of a multi-kW excimer laser. A laboratory prototype of an excimer laser was successfully tested and gave an average output of 0.75 kW. This version works at relatively low pulse energies and a high repetition rate. In the project's second line of research, which aims to achieve high output with high pulse energies, it proved possible to reach more than 4.5 joules pulse energy with uniform distribution over a surface measuring approximately four cm by five cm. Both of these results are world records. Other work has identified optical materials whose properties suggest that they could be used to make optical components (windows, lenses) that could withstand such a high beam output. Application surveys confirm the high potential for excimer lasers that is emerging in, for example, ceramics and textile processing or the production of high temperature superconductors. In Project EU 226 the experimental version of a one-kW solid-state laser was built with conventional technology and successfully tested. At present, work is being done on improving beam quality, which is important for applications, and on application studies designed to orient research. Laboratory mock-ups of alternative solid-state laser concepts using new technologies (slab lasers, tube lasers) have been or are being built. As with excimer lasers, work on the optical components is beginning to give initial results. For example, methods for enhancing the capacity of the laser-active crystals and antireflection coatings have been found.

The first experience in Europe of processing materials with 20-kW class CO_2 lasers was gained with French partners under Project EU 194. The first important step

was to ensure safe handling and control of a laser system in this output class. Suffice it to quote just two examples from the many detailed results obtained in practical materials processing. The high laser output makes for welds of up to three cm (instead of one cm), or surface processing up to two cm (instead of 0.5 cm) wide. Correspondingly drastic increases in processing speeds are, of course, another way of fully utilizing the high output. The studies clearly show that there is a wide range of commercially viable potential applications for lasers in this output class. The initial phase of Project EU 204 (laser surface processing cell) has been successfully completed. The components suitable for flexible processing in this cell (shafts, forging dies, gearwheels, turbine rotor blades) were identified and the requirements for the laser unit were defined accordingly. Orientation tests for online process monitoring were equally successful. These results are currently being used to design and build a prototype.

Work on the CO laser project (EU 113) is still of a very fundamental nature, as hardly any data on materials processing with this type of laser exists. Initial research showed that certain metals absorbed a somewhat higher level of radiation, although it has not yet been possible to confirm Japanese reports of considerably higher process cycle speeds. Further experiments are still required for conclusive confirmation of these results.

Philips Advances in Fiber Optics Described

90CW0150C Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 25 Jan 90 p 8

[Unattributed article: "New Fiberglass Equipment Reduces Costs by Approximately One-Third—Philips Introduces Fiber Optic Cables/Direct Computer Connection via the Ethernet PC Circuit Board"]

[Text] The construction costs of fiberglass lines can now, in the opinion of the Philips Communications Industries, Joint Stock Co., be reduced by as much as 30 percent, provided a new concept for cable bundles, cable sets, and the appropriate communications equipment are utilized. At the center of the concept are special cables which are no longer produced in the customary manner, but instead contain fiberglass fibers. According to the information provided by the enterprise, such a cable bundle consists of 10 adjacent glued-together monofilament fibers. Up to 10 bundles of fibers, lying loosely one on top of the other, are incorporated into a plastic pipe.

This pipe is the central element of the cable. The cable is covered in a manner which has been customary for fiberglass cables thus far. This cable design has an external diameter which is 50 percent smaller than customary fiberglass cables. This is supposed to make it possible to pull the cable bundles through cable conduits faster during assembly. Moreover, the cable bundles can be packaged with a varying number of bundles without altering the external diameter, according to need.

For this kind of cable design, Philips Communications Industries (Communications Cables and Facilities, Piccoloministr. 2, 5000 Cologne 80) has also developed connecting, branching, and final distribution cable sets. The central element of the cable connectors are said to be cassettes which can accomplish firm bundle connections. To produce them, it is said that a new multiple splicing work site is available for stationary or even mobile application. In a time-saving process, the 10 fiberglass fibers of each bundle may be spliced at the same time.

After depositing the fiber bundles and after preparing the terminal surfaces, the fibers are inserted into special multiple ports of the instrument and, subsequently, in a computer-controlled process "welded together" with a laser light beam. The enterprise reports that, for purposes of ranging units, it is possible to feed complete bundles of cables into a splicing device. It is only within this deposit phase that the bundle in question is separated into the individual 10 fibers. At the front part of the sorting device, soluble connections are used to attach plastic jacks which were specially developed for the local network.

Philips says it has also developed appropriate synchronous optical ethernet PC circuit boards so as to facilitate the attachment of personal computers to the synchronous optical local network (LAN). These devices already make it possible today to accomplish cabling in accordance with the principle "fiber to the desk." With its LAN Opto 100, the enterprise also has a high capacity network in its program as a local network which can operate with data rates of up to 100 Mbits/sec. This Opto 100 is said to be a double ring in which the communications junctions are coupled in accordance with the Standard Fiber Distribution Data Interface. Philips Communications Industries intends to demonstrate this new equipment for the first time during the Hannover CeBIT Trade Fair this year.

MICROELECTRONICS

JESSI Members React to Siemens-IBM DRAM Project

90CW0170A Paris ELECTRONIQUE ACTUALITES in French 2 Feb 90 p 10

[Article by D. Girault: "There Must Be Reciprocity - The Reactions of the JESSI Participants"]

[Text] The IBM-Siemens agreement and its corollary, IBM's entry into JESSI [Joint European Submicron Semiconductor Initiative] will bring about a recasting of at least part of the European program. Indeed, a reshaping of the DRAM [dynamic random access memory chip] subprogram has already been broached, according to Mr Knapp, JESSI spokesman. IBM would participate in the new subprogram to be presented to the JESSI board for approval. Already Philips and SGS-Thomson have nothing to fear from IBM's participation.

For example, concerning Philips "this American participation in European programs was foreseen. We agree, on condition that there be reciprocity. Along these lines, we hope that IBM will participate in JESSI and will help European firms gain access to American programs." Big Blue's participation is expected primarily in hardware, since Europe falls short in this area. The data processing giant will be making proposals in the JESSI group as early as next March, on the subjects of manufacturing equipment and materials.

The 64 Mbit DRAM Sooner Than Foreseen

The JESSI actors prove sensitive to an important fact: the IBM/Siemens agreement will allow them to market 64 Mbit DRAMs sooner than forecast. By JESSI's calendar, these should go into full production in 1996. This is why inclusion of the agreement in the JESSI framework should easily win the concurrence of the participants. Indeed, why turn down such a windfall? Meanwhile a mitigating consideration: experts say the 1995 market for the 64 Mbit DRAM will only amount to 150 million dollars! And, in the 22-billion dollar world-wide DRAM market (1994 estimate), only the fringes will go to the 16 MBit chips. So the 64 Mbit chips are still a long way off, unless the 16 Mbit step is skipped, considering life-cycle product support on one hand and the investment needed to launch a whole new generation of memories on the other. Today in Europe, Siemens is the only JESSI member working on a 16 Mbit DRAM (which requires mastering 0.5µm CMOS technology). According to the JESSI calendar, these 16 Mbit chips are expected to be produced in volume in 1993 - 1994.

The Siemens/IBM accord would upset the DRAM schedule. The 64 Mbit chips could come out more quickly than the 16 Mbit chips.

SGS-THOMSON into the 4 Mbits?

SGS-Thomson is another European firm interested in DRAM. SGS-Thomson, still waiting for its turn in the DRAM business, could profit from present circumstances by investing in the 4 Mbit DRAM market. Indeed, investments are traditionally made in a difficult period, the slack season before a recovery. Right now, the 4 Mbit DRAM market is still in its formative stages. The overall chip market should pick up during the second semester (especially in the last trimester). An extension of the agreement with Oki to encapsulate 256 Kbit and 1 Mbit DRAM chips, could come about this year. Oki has already signaled that this agreement could be extended to include distribution of the chips. However, this accord does nothing for SGS-Thomson's part in JESSI: Siemens, a Megaproject partner with Philips, has already developed a 1 Mbit chip with Toshiba.

As mentioned above, IBM's participation in JESSI is based on reciprocity. The JESSI actors ask what openings there might be in American programs. Sematech is not the only game. Philips, for example, has specified some other projects that interest them, like HDTV [high density television] (joining Philips, Thomson and the Americans). For all that, Philips intends to ask for a part in Sematech, counting on IBM support. On this subject, Mr Knapp says, "it is too early to call for the entry of European companies into Sematech and American companies into JESSI." Sematech and JESSI representatives have carried out discussions. They defined areas of mutual interest in a meeting last December (see ELECTRONIQUE ACTUALITES of 12 Jan 90). These include an assessment of the hardware on the current market, standardization of software tools and materials, and the development of manufacturing equipment. At the end of next March these subjects, worked out at this point by the two teams, will be submitted to the head offices for final approval. An agreement between JESSI and Sematech could be ratified by the middle of next year. IBM will have helped a lot. They have been working, especially since June of 1989, on the reciprocal opening of the American and European programs.

In all likelihood, this rapprochement between the United States and Europe will witness a reinforcement of the solid front of the two communities toward Japan. It could serve as common ground for discussing with the Japanese the thorny problem of opening their market!

European Reactions to EC Protectionist Measures

SGS-Thomson Official Critical

90CW0169A Paris ELECTRONIQUE ACTUALITES in French 16 Feb 90 p 9

[Article by D. Girault: "According to Mr Geyres (SGS-Thomson),European Protectionism Is Inadequate for Semiconductors"]

[Text] The SGS-Thomson management has said it is unsatisfied with the measures taken by Brussels to introduce floor prices affecting DRAM's [dynamic random access memory] from Japan. These measures are far from being deterrent, according to Philippe Geyres, director for strategic planning of the Italian-French company. This statement is somewhat surprising: it takes exactly the contrary position to that of the EECA (European Electronic Component Manufacturers Association), which said it was satisfied with the compromise on DRAM's arrived at with the Japanese!

The fact remains that, in Mr Geyres' opinion, it is imperative, at the very least, to retain sufficiently high customs duties in response to the "non-opening-up" of "fortress Japan." This is not an innocent proposal: it comes at a time when the GATT Conference is indeed planning to reduce customs duties by the amount of 30 percent.

The vice president thus showed he stands firm. In his view, Europe should adopt a stance that is as protectionist as Japan's. However, he did not hide the major difficulties that the measures he would like to introduce would encounter, specifically: the difference in opinions of the Twelve on the effectiveness of such measures (the

United Kingdom and Ireland have opened their doors to the Japanese); and the resistance of equipment suppliers, especially computer equipment suppliers, who face the eternal problem of providing DRAM memories.

General Public, Semiconductors Relationship

In the view of Mr Geyres, the health of Europe will come from the general public. The developments in that market and the semiconductors market are closely linked. Mr Geyres cites as proof of this the Japanese simultaneous hold on both these fields that has emerged; the Japanese have taken over 50 percent of the general public and semiconductor world markets. The cause of this is the famous Japanese vertical structures: Matsushita, the leading world manufacture in general public items ($15.7 billion 83 turnover in 1989), is 64-percent self-supplied in its semiconductor division; Sony, third in the world ($11 billion turnover in 1989), is 60-percent self-supplied.

However, the SGS-Thomson vice president is optimistic. Philips and Thomson are ranked second and fourth worldwide in the general public market, and have decided to work together in developing an HDTV [High-Definition Television] standard; recently they dotted some i's in the United States by uniting with NBC (TV network) and the David Sarnoff to face the Japanese. As for the performance of the Europeans involved with semiconductors, they are "more than significant," in Mr Geyres' opinion. He recalled that Siemens and SGS-Thomson had achieved record growth rates. Three European operators now appear on the honor list of big companies: Philips (10th in the world), SGS-Thomson (12th) and Siemens (15th): they are also the three initiators of Jessi, a program aimed at opening toward the West. Let us recall that IBM has been invited and that the computer giant is currently preparing proposals in the field of manufacturing equipment, the Achilles heel of Europe.

In Mr Geyres' view, it is absolutely necessary to establish procedures to enable combat on an equal basis with Japan. Thus, that country must be forced to open itself up. Indeed, while the Europeans supply only 37 percent of their semiconductor needs, Japan self-supplies up to 86 percent.

According to Mr Geyres, the reasons cited by Japanese manufacturers are that they find it impossible to obtain, on the one hand, the products that they need, and, on the other, the quality that they want.

Fallacious arguments, comments the SGS-Thomson vice president, who adds that it is either specialized or outdated products, not produced by the country's manufacturers, that are purchased. Proof of this is that the companies that prosper in Japan are analog specialists (Burr-Brown, etc.), a field that Japanese production does not cover. The pattern is the same for the general public market: while the Europeans supply 37 percent of their needs, the Japanese fill 95 percent of their domestic demand. If the opening of "fortress Japan" were achieved, the figures would be very different; the Europeans would supply 10 percent of the semiconductor market and 20 percent of the Japanese general public market!

Halt to Opening Up Europe

In his address, Mr Geyres stressed that Japanese installations in Europe must not be subsidized, explaining that the Japanese are playing the game of setting the various countries of the Common Market in competition with each other. The vice president also stressed that serious measures should be taken such as continuation (or even strengthening) of customs duties. Thus, a recurring theme of a reexamined problem that finds no solution, or, at best, solutions regarded as unsatisfactory. Thus, it is p73 time for the manufacturers, equipment suppliers, and legal-political bodies to tune their violins together, so that the problems, on the world level, can be debated, while recognizing the involvement of electronics in a broader economic landscape, from which not even agriculture is absent!

Competitive Strategies Discussed

90CW0169b Paris ELECTRONIQUE ACTUALITIES in French 23 Feb 90 p 9

[Article by D. Girault: "Facing Japan: The Europe of the Semiconductor: Not Together"]

[Text] While Mr Geyres, vice president of SGS-Thomson, argues for strengthening of European protectionism, the members of the EECA (European Electronic Component Manufacturers Association) are far from unanimity on the issue of mobilization against the Japanese. In short, it is the European solidarity among semiconductor manufacturers rallied around the Jesse banner that poses the problem. The strategies of the three "European giants" (Philips, SGS-Thomson and Siemens) differ: while there is recognition of the difficulty of penetrating the Japanese market and the necessity for each to increase its competitiveness, the reasons for these difficulties are not understood by each in the same way.

While the EECA has shown it is satisfied with the floor prices for DRAM's from Japan, a view shared by Siemens, SGS-Thomson protests at the futility of measures that, far from being dissuasive, are virtually indirect aid to financing "the Japanese war machine." Philips Components is off on its own, saying that it is more concerned about the problems involved in SRAM's [static random access memory]: the Netherlands company thus does not criticize adoption of floor prices.

Each of the three European semiconductor giants is thus looking out for itself. In face of the Japanese power, a power which is itself as divided, a power which extends throughout the world, establishing production units in Europe, Asia and the United States, the Europeans, like the Bagaudes of Gaul in their time, are trying to exploit the situation, each in his own way.

As for the two major American suppliers, Motorola and TI [Texas Instruments], respectively fourth and sixth in the world ranking by Dataquest for 1989, they declare that they are satisfied with their progress in Japan.

Siemens: Europe First

Siemens, the leading European supplier of DRAM's with $350 million in sales in 1989, clearly displays a strategy of European conquest, not having the capacity to supply all the markets. In the view of the West German semiconductor manufacturer, which is also an equipment supplier, the floor prices prove to be adequate measures, like a railing against a price collapse that is always foreseeable in a market as sensitive as the DRAM market. These p73 measures do not bother an equipment supplier such as Siemens. Everything is thus fine for the West German company, which believes that strengthening protectionism would be a mistake. This weapon should only be used as a bandage for protecting a sick industry (are the European industries that?). The important thing, as the company has proved by the massive investments it has approved, is to regain competitiveness.

First, investments, and thus regain the competitiveness (with the purpose of a healthy increase in productivity, which in Europe remains lower than that of the Japanese). Subsequently, investments in Japan itself. Two essential conditions for succeeding in the Land of the Rising Sun.

The Japan of TI and Motorola

Two American companies, Motorola and TI demonstrate what a successful establishment in Japan can be. TI, which has been established for some 20 years on the islands, occupied some 2.5 percent of the Japanese market in 1989, representing about $500 million, or 18 percent of the company's turnover in 1989. In 1989, Motorola enjoyed 2 percent of the Japanese market, or $400 million, representing 12 percent of its sales last year: the company said it was satisfied with its progress in the islands market. It considered that this result was the consequence of its policy of investments in the joint unit established with Toshiba in 1986, as well as in the ASIC [application specific integrated circuit] design centers and, more broadly, the IC centers established in Japan. TI also affirms that it has always proclaimed itself a fervent supporter of liberalism, regarding itself as as European as American or Japanese.

Motorola explains that it is difficult to evaluate the fallout of investments, since they can be indirect: for example, projects designed in Japan can bear fruit in Europe, or a Japanese equipment supplier may favor the company with whose catalog he is familiar. On the issue of floor prices, Motorola clearly proclaims that it has kept track of the movement, while being in no way its instigator.

It should be noted that Motorola and TI (for the same reason as NEC), are members of the EECA, having been established in Europe for a long time. And the two American companies were able, during the difficult years (1985/1986), to play the game of worldwide expansion, thereby putting themselves outside the sphere of the U.S.-Japanese agreements.

Now: can the three Europeans, following the example of their American peers. succeed in each adopting an original relational strategy, leaving any European-Japanese agreement "to live its life," or, better, knowing how to benefit from it!

TECHNOLOGY TRANSFER

FRG CEO Discusses Joint Venture with GDR Firm Robotron

90CW0172A Munich HIGHTECH in German Feb 1990 pp 6-7

[Interview with Reiner E. Pilz, entrepreneur from Kranzberg, by HIGHTECH; place not specified: "Push to Individual Dynamics"]

[Text] The first to enter the mid-sized high tech area, entrepreneur Reiner E. Pilz from Kranzberg undertook a joint, German-German partnership project full of risks. While others still hesitate, the pioneer, along with his partner Robotron, already sees more far-reaching prospects than just the production of compact disks.

HIGHTECH: Mr. Pilz, the legal and economic conditions for joint ventures in the GDR are still on shaky ground. Where does your certainty come from that your project with Robotron will turn out well?

)Pilz: The innovative mid-sized entrepreneur cannot always wait until all of the pre-conditions are secured. Sucessful entrepreneurs always look upon themselves also as trailblazers and pioneers. Robotron knows that I am a no-ifs-ands-or-buts capitalist. To the managers of this combine who are oriented toward Western standards, it is absolutely clear that I want to profit from this new, joint enterprise.

HIGHTECH: We doubt whether your hope for success will be sufficient.

Pilz: The agreements for this joint venture, in which I have a one-third interest, have been secured by decision makers and show the trend toward the emergence of a free market economy, a free foreign currency exchange and an absolute renunciation of the imposition of a planned economy. I expect that we will soon have a convertible GDR currency. Some fine-tuning in the contract process is certainly still necessary but this does not change the fact that this is basically a pilot venture.

No Interest in Obtaining a Controlling Majority

HIGHTECH: Have you, at least, been able to secure an option for increasing your share in the company?

Pilz: This would be perhaps Siemens's way of thinking, demanding at least a 51 percent share for itself. I, on the other hand, am not interested in obtaining majority interest in an enterprise in the GDR.

HIGHTECH: This is astonishing because, as a rule, whoever has a larger share, also has greater influence.

Pilz: Not necessarily; that depends, first of all, on the formulation and interpretation of the contracts. For example, during the first three years, we take over the entire technical and managerial responsibility for the joint venture. Furthermore, we have committed ourselves to train the personnel where, with respect to staff selection, we will certainly not proceed according to the Party book. It is agreed that positions will be filled exclusively on the basis of qualitative considerations.

HIGHTECH: Honestly now, how much cheaper will you be able to produce in the GDR than in the Federal Republic?

Pilz: Not at all. We do not look at the GDR as a country of cheap wages. Our project there is not to be seen as an extended workbench but as a fully automated high-tech enterprise where highly qualified workplaces will be created and where labor cost will play a subordinate role.

HIGHTECH: Then your investment is rightly ranked as private economic developmental assistance?

Pilz: You are mistaken because it boils down to the prospect of healthy profits in which I shall participate. This investment is not into a colony but a self-standing enterpise from which I shall simply withdraw, perhaps by selling on the stock market, when it becomes completely functioning and profit-making.

HIGHTECH: As yet, there are not even enough CD players in the GDR on which the disks could be played.

Pilz: The GDR has just imported an initial 100,000 players from Japan. We figure on a domestic demand for five to eight million compact disks within the next three to five years. Robotron has even considered setting up its own equipment production which, however, I advised them not to do. The GDR must get rid of its habit of wanting to produce everything itself which indeed probably had to be so before because of the COCOM [coordinating committee] list. The chips and laser for CD players, patented in Japan, could be produced only at the cost of new dependencies; it is cheaper to purchase them.

HIGHTECH: For which markets are the CDs, produced in the GDR, targeted and did you insist on exclusionary clauses?

Pilz: No, the production is aimed at both, meeting domestic demand and also export to the world market. We entrepreneurs of the Federal Republic must go with such ultra-modern production lines to where the demand is and we must cease to use those forms of economic colonization which makes others merely dependent. The Japanese conduct the third World War in this manner whereby they create lasting dependencies.

HIGHTECH: Beyond your activities in the area of entertainment electronics, what other plans do you have?

Pilz: One of the many points of departure for cooperation is software development. Together with Robotron, it is our goal to equip every personal computer made in the GDR with a new generation of CD-ROM-drives and to offer them as a complete unit meeting world market conditions. I see here an enormous growth market.

HIGHTECH: Nevertheless, the export of high technology installations is rather problematic. We know of a great number of failures.

Pilz: Such fears are not applicable to the GDR. People there are very well educated and the creation of future-oriented workplaces will release unimagined motivation. Therefore, it makes no sense to dismantle the old sheds and machines here and build them up again there, on the example of VW. The GDR needs new investments with new technologies and modern production methods in order to be able to assert itself on the world market.

HIGHTECH: You demand a lot of initial achievement here since the rules of the game are not yet established.

Pilz: Maybe, but I am firmly convinced that medium-sized businesses must become active on their own, without waiting for governments and their hundred percent guarantees. The best functioning method is to develop a turnkey-ready idea and then search for a partner in the GDR. Through joint ventures, cooperations and the transfer of know-how, a special dynamic arises which simply can no longer be held back. If we are too hesitant now, renewed fragmentation can be the result.

Increase in GDR Requests for Research Grants Viewed

90CW0157B Duesseldorf VDI NACHRICHTEN in German 16 Feb 90 p 2

[Article by M. Peter: "No Bonus for German-German Projects"]

[Text] The inquiries come from Leipzig per Telex. A professor of medicine is on the way to Bonn to the DFG [German Research Association]. His objective: to get money for a research project that he and researchers at Ulm University want to pursue.

The DFG could not help. To be sure, it has expanded its sponsorship programs for joint undertakings, but GDR scientists, according to DFG statutes, cannot receive direct aid. Colleagues in the West have to file the application and then send the appropriate amount to their partners in the GDR. There are no DFG funds, aside from certain exceptional cases, for GDR individuals, only for equipment, materials, and trips. This rule,

the DFG says, was instituted on the recommendation of East Berlin in order to avoid a flood of applications.

The background: GDR institutes are overstaffed. Even with half the number of people, both FRG and GDR observers agree, good work could be done. Where 200 researchers may be used in a Max Planck Institute, 2,000 would be engaged on the same project in a large physics institute in the GDR. To assure serious cooperation, a DFG associate says, the "other side should not be exempted from all financial responsibility."

The Bonn Research Ministry has made requests for supplementary budget funds so that FRG research is not forced to be cut back because of the expanded cooperative programs. If the budgetary funds are approved in the amount foreseen, German-German scientific cooperation will be bolstered by DM 5-6 million. The earliest the funds can begin to flow is July of this year. While the DFG wants to decide quickly, it will not lower its quality assessments of the applications. "There are no bonuses for German-German projects," DFG has let it be known.

Only basic and applied research will be sponsored. It is precisely in basic research that the GDR needs to do a great deal of catching up, since, as one DFG associate describes it, "it has been terribly strangled" over the past years.

In some aspects the DAAD [German Academic Exchange Service] has far exceeded its quota for the exchange of students and young scientists. Applications from FRG students short periods of study in the GDR and by GDR students for short stays in the West are particularly numerous.

The Volkswagen Foundation has been developing contacts with scientific enterprises in the GDR for three years. The overture has become so well known that the Foundation is drowned in a flood of applications. 120 applications totally DM 40 million are now piled up in Hannover. A good three-quarters of the engineering and natural scientists have already been placed.

At a committee session to be held in March, some of the applications should be processed in an "approval thrust." But just as the DFG, the Volkswagen Foundation will not lessen its grant criteria, regardless of the number of applicants.

The Foundation, which is situated in Hannover, hopes to improve the research infrastructure in the GDR with another emergency program. DM 10 million have been set aside for books and equipment. But the patron institution has still another problem to contend with in distributing the funds, namely, a lack of specific information. So far very little is known as to how much of what is needed where in the GDR. The universities do not even have course schedules, which could be used as a guide. Consequently those GDR scientists and institutes that present their cases forcefully have a very good chance of winning out.

But even then there is another hurdle to overcome. When a project has received approval, the question then arises as to how long the participating GDR scientists will remain in office. 80 percent of the professors are or were SED [Socialist Unity Party (Communist)] members. At the current accelerated rate of change, it would be impossible to predict how many of them will be required to vacate their positions.

ADVANCED MATERIALS

Hungarian Aluminum Industry Develops New Materials, Technologies

25020012a Budapest KOHASZAT in Hungarian Feb 90 pp 81-84

[Article by Gyorgy Keebe: "New Materials, New Technologies in the Aluminum Industry"]

[Excerpts] The aluminum industry of the world is going through profound structural changes. Signs of saturation are appearing on the traditional markets and the competition with other materials is increasingly sharp. [passage omitted] Development is proceeding in two directions. One is the step by step improvement and optimization of traditional alloys and processes; the other is the production of new materials (alloys) the more favorable properties of which are realized by new manufacturing technologies. [passage omitted]

At the semiproducts development office of ALUTERV-FKI [Designing Institute for the Aluminum Industry] we have been dealing for two years with research on new materials and new technologies. As a first step we defined those developmental trends which we could cultivate by slightly supplementing the available technological equipment. These are: a technology to ensure superplasticity, aluminum powder metallurgy based on fast cooling, and production of aluminum based composites. [passage omitted]

The practical achievements thus far of research at our institute in connection with superplasticity are the following:

—We achieved 400-500 percent deformation under laboratory conditions on special AlZnMgZr alloys.

—We measured 300-350 percent stretching modelling a thermomechanical process for 7475 AlZnMgCuCr material under laboratory conditions.

—We performed plant experiments (billets with cross sections of 300-800 mm) on 6061 AlMgSiCuCr materials and achieved stretching similar to the 7475 material.

—We produced from an AlMgSi alloy a fine particle structure, highly plastic sheet material using factory equipment. [passage omitted]

As a result of the experiments we expect to begin factory production of AlMgSi superplastic sheet in 1990. [passage omitted]

A special powder metallurgy process serves to produce fast cooled metal. Aluminum powder with a particle size of 40-200 microns is most commonly produced with gas pulverization. This is how we prepare experimental alloys at the ALUTERV-FKI also. We then prepress the powder breaking up the oxide skin covering the particles with vacuum heating, finally "welding" the particles together with hot pressing. Thus during the entire technology we disintegrate the bulk material, thus producing the fast cooled metal, and then prepare from the powder a new bulk material which has the favorable properties of the fast cooled metal.

Uniform materials produced from two or more components are called composite materials, but the components in the finished material preserve their original state. [passage omitted] The most common form of aluminum based composites consist of the metal (an aluminum alloy) and very strong additives which may be long or short whiskers or powders. [passage omitted] Short fiber strengthened aluminum alloys are used in Japan in the valve system of automobile engines and their domestic use can be expected primarily in the vehicle industry. Basic research connected with composite materials at our institute has already clarified the basic questions of the production and use of composites. The development of experimental laboratory equipment is now under way.

COMPUTERS

GDR: Image Processing System Based on KC 85/3 Computer Described

90CW0151A East Berlin RADIO FERNSEHEN ELEKTRONIK in German No 1, Jan 90 pp 24-26

[Article by Konrad Malsch, graduate engineer, and Dietmar Sieland, graduate engineer: "Image Processing System Using the KC 85/3 Computer"]

[Text] For years, great efforts have been undertaken in the people's economy of the GDR to accomplish an ever greater measure of automating entire production lines. In this endeavor, particular attention was paid to such operational procedures which involve great deals of physical and mental stress for man. In order to accomplish complete automation solutions, it is desirable also to replace the visual cognitive capabilities of man. It is precisely in the area of quality control and quality assurance that this turns out to be of particular importance, but is also particularly difficult. The reasons for this are the multiplicity of possible errors which can frequently only be recorded with the aid of the great performance capability inherent in human visual and cognitive capabilities. On the other hand, there is the unreliability of manpower, particularly when operations are monotonous or complex, and the resulting need for automation.

In order to be able to replace the visual cognitive capabilities of man, a reliable recognition system is desirable. In industrial practices, there is a multiplicity of such visual recognition systems. Many of these systems are based on personal or office computers and are, for these reasons, connected with high investment costs.

At the VEB "Wilhelm Pieck" Microelectronics Plant at Muehlhausen, therefore, an image processing system

based on the KC 85/3 computer was created which is in a position to analyze images in a format of 312 x 256 image points. The system can also be operated with the KC 85/2 computer without requiring any changes in hardware. The difference with respect to other image processing systems consists in the fact that image acquisition, processing, and analysis are accomplished with the aid of the graphics-capable KC 85/3 computer and that this computer system can be adapted to many uses on the basis of its modularity without resulting in problems.

An important advantage consists in the fact that the image processing system is made up of essentially generally available standard equipment and is, thus, accessible to anyone and is realizable with comparatively modest investment expenditures. Only for direct attachment of the camera is a special module used.

The image processing system produces and processes digital black-and-white pictures. The data reduction, based on the utilized binary image process, facilitates a high degree of evaluation speed so that the requirements posed by solutions of industrial tasks can be fulfilled in real time.

On the basis of the above characteristics, the image processing system can be used, for example, to recognize the attitude position of objects, to perform longitudinal and diameter measurements, to verify structures, and, last but not least, for advertising purposes.

Makeup and Parameters

The following are essentially components of the image processing system:

- a KC 85/3 computer with keyboard and monitor;
- an image processing module;
- a user-PROM module;
- a Model FK 2010 television camera with a network hookup or a TFK 500 or TFK 1010 television camera;
- a control monitor

The FK 2010 and TFK 500 or TFK 1010 are standard TV cameras produced by the VEB Studiotechnik Enterprise of Berlin. Since these types of cameras are synchronized by remote control via the video timer and DMA module and since the BAS signal must be transmitted back to the module, minor changes in the cameras are desirable which are described in more detail in the supplemental use documentation [1]. The TFK 500 and the TFK 1010 cameras offer the advantage of having the network hookup already integrated in the cameras. With respect to the FK 2010, additional room for this is necessary.

The most important technical parameters of the image processing system are contained in the table below.

Selected Technical Parameters

Item	Parameter
Image rate	50 images/sec, excluding line-interlace procedure
Image format	256 lines of 312 image points each
Video cycle frequency	7.1 MHz
Processing width	1 bit/pixel
Time required to digitalize one image	Approximately 20 ms

Description of Function

All of the supplemental hardware to control the camera and to store the image is contained in a standard KC-user module (see Figure 1).

The heart of the module is the control cycle generator which produces all of the control signals for the intermediate storage, for DMA control, and the address multiplexer, as well as for the horizontal and vertical synchronization signals for the camera. For this purpose, the control cycle generator evaluates the defined counter stages of the horizontal (D_{15}, D_{18}, D_{19}) and the vertical counters (D_{20} through D_{22}). These counters are similar to those used in the KC 85 basic device to produce the video image. For purposes of simplicity, the video cycle is regenerated from the quartz-stabilized computer cycle. The special line and image content signals (Zl and Bl) of the KC 85 basic computer serve to synchronize the camera image with the computer image so that defined irregularities in the computer cycle do not occur. Using frequency-increasing circuits of a known design, this basic computer cycle is quadrupled in the module and made available as an m0 video base cycle.

The camera delivers a standardized BAS signal. This signal is digitized within the module with the aid of a rapid A-D converter. Since the converter essentially consists of a comparator N_1 with an externally settable switching threshold, the processing of halftones is not possible. Nevertheless, the data stream which has thus been reduced to something like 0.89 Mbyte/sec can be recorded directly in the image buffer storage unit via the DMA circuit. A slide register (D_{30}) is used to transform the serial image signal into the data format of the 8-bit processor, and the results of the slide register are made available after every eight slide operations in a latch (D_{30}) which is coupled to the processor data bus. The multiplexers (D_9, D_{27}, D_{29}) provide the necessary storage addresses in the sequence required by the organization of the image repeater storage device in the KC 85/3. Thus, the software-controlled reloading of the image buffer content into the image repeater storage device can occur without expensive address computations.

The control signals for the DMA cycle (see Figure 3) are generated from the video cycle with the aid of a few TTL circuits. In this connection, the DMA controller IS UB 858 D is not usable because, at the given computer cycle frequency of 1.75 MHz, it permits a maximum data transfer rate of only about 0.87 Mbyte/sec. The counter D_{16} which is controlled by one-half of the pixel cycle m1, separates the DMA cycle into 1 byte each in four phases. According to the counter status, a multiplexer (D_{17}) produces the control signals necessary to register data in the image buffer storage /MREQ and /WR, whereas the

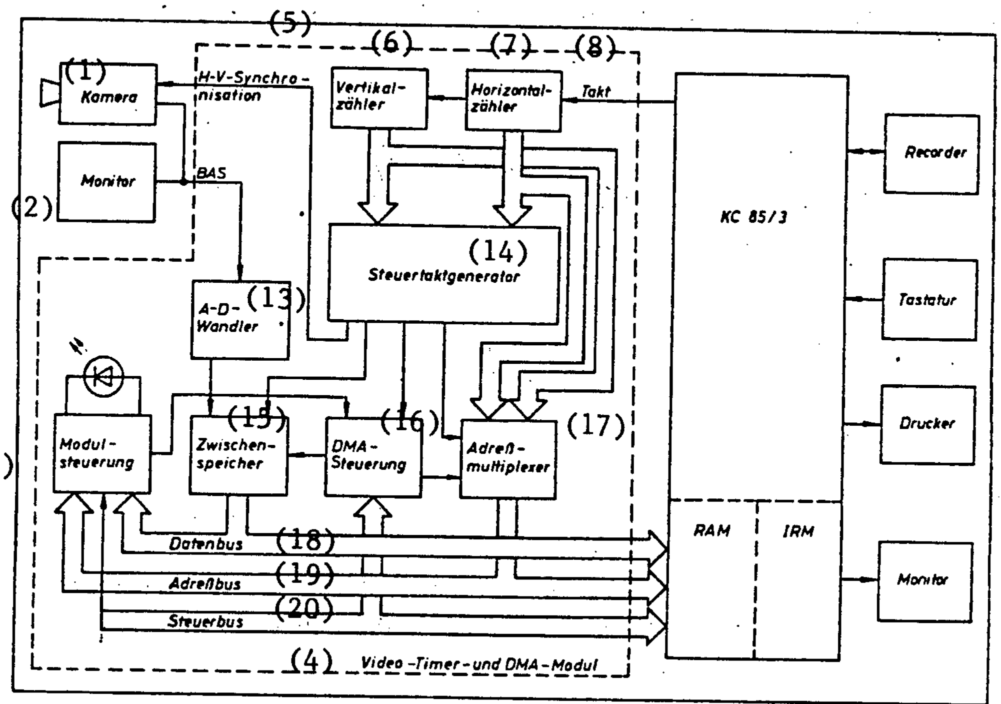


Figure 1. Block diagram of the video timer and DMA module showing the connection of all external equipment. Key:—1. Camera—2. Monitor—3. Module control—4. Video timer and DMA module—5. H-V synchronization—6. Vertical counter—7. Horizontal counter—8. Cycle—9. Recorder—10. Keyboard—11. Printer—12. Monitor—13. A-D converter—14. Control cycle generator—15. Intermediate storage—16. DMA control—17. Address multiplexer—18. Data bus—19. Address bus—20. Control bus.

unneeded control circuit /IORQ and /RD are kept statically inactive by a bus-drive circuit. In phase 1, (counter status 0) an active line and image content signal activates the circuit /MREQ which results in the line selection signal RAS for the addressed storage unit being generated by the KC 85/3. The desirable delay time required for column selection (CAS) is guaranteed by the DMA phase 2 (counter status 1). The write signal /WR, which is turned on at the beginning of phase 3, leads to the activation of the /CAS circuit in the selected storage portion of the KC 85/3. When all control signals are turned off in phase 4, the next storage write cycle is prepared.

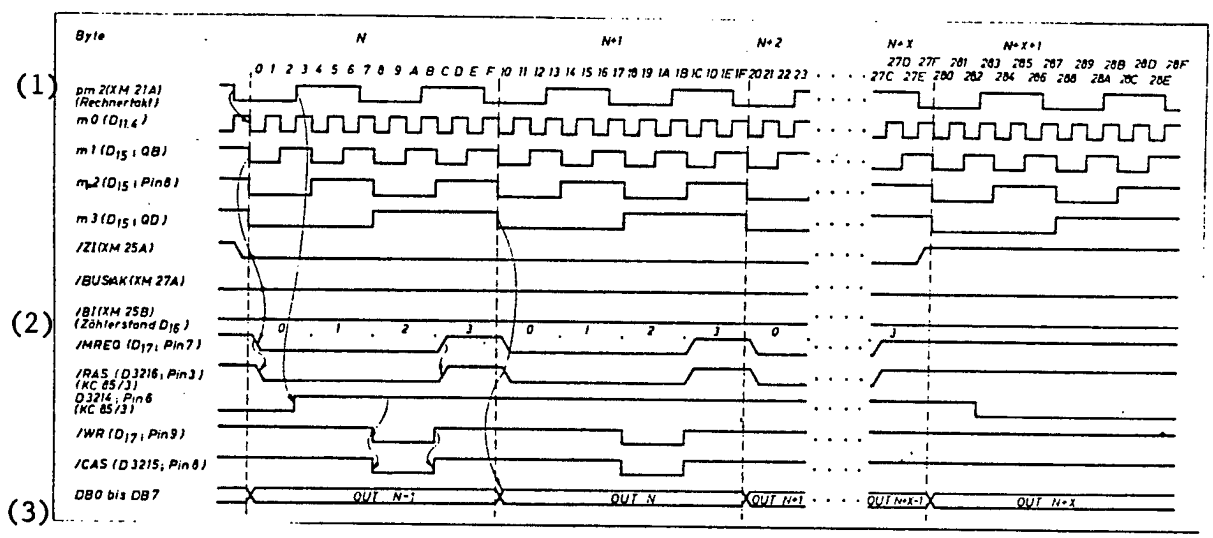


Figure 3. Cycle diagram for DMA control.
Key:—1. (Computer cycle)—2. (Counter status D_{16})—3. DB0 through DB7.

The module controls (D_1, D_2, D_4, D_7, D_8) can, controlled by the software, introduce the DMA cycle for the duration of one image. For this purpose, D_{13} ties the On signal of $D_{7.1}$ (On) to the decoded line number 311 of the last depicted image and, using a Flip-Flop ($D_{8.2}$), initiates the bus requirement /BUSRQ. The feedback from the processor in the form of the BUSAK signal is utilized to alleviate the high ohm status of the starting stages which exert an influence upon the computer bus. After transmission of a camera image into the computer storage, the Flip-Flops $D_{7.1}$ and $D_{8.2}$ are reset upon encountering line 311. The timer N_2, which stretches the starting Flip-Flop signal from the $D_{7.1}$ in terms of timing and displays it on the LED B_1 display, is used to signal the active module status, which only lasts about 20 ms.

The storage module is also used to store the basic address A14, A15 of the image buffer storage in $D_{7.2}$ and $D_{8.1}$.

Thus, the image can be stored in the storage device, as a result of software control, effective with the addresses 00000H, 04000H, 08000H, or 0C000H. The structure byte OCFH, which is prepared by the module control, is altered during the DMA cycle (V_1, V_2) and can be evaluated as a feedback signal in the user program.

Program Description

The supplemental user documentation which makes software available pertaining to the image processing system essentially encompasses the basic system initiation, as well as the reading in, the erasing, the printing, and the saving of digital images. Based on these routines, the user is able to create his own application-specific image recognition and processing programs.

The machine code for the above program was located at address 04000H. It is, thus, possible to deposit the software in an M 025 module (8 K user-PROM). If suitable circuit technology measures are used to cause this module to transmit the structure byte 001H (upon request by the computer) and if the module is used in socket 8 of the KC 85/3, the program is started automatically when the computer is turned on. Otherwise, the program start is initiated via the CAOS menu entry "PINIT," without noting its parameters.

The total program occupies approximately 2 Kbytes of memory and can only be run on the KC 85/3 computer. Derived variations of the program for the KC 85/2 must, in the case of need, be adapted by the user himself.

Examples of Application

At the pocket calculator final control station in the VEB "Wilhelm Pieck" Microelectronics Plant at Muehlhausen, pocket calculators are tested with the aid of a multistage test calculation program for their functionality. The fundamental prerequisites for the automation of this work process is the mechanical evaluation of the content of the display. For this task, the above-described image processing system can be used and it makes use of special software to evaluate each individual bar of the seven-segment display.

The required supplemental user documentation for the image processing system can be ordered from the VEB "Wilhelm Pieck" Microelectronics Plant at Muehlhausen, Department EV1.

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FACTORY AUTOMATION, ROBOTICS

GDR: Wear Assessment Sensor Technology for FMS Described

90CW0175 East Berlin FERTIGUNGSTECHNIK UND BETRIEB in German No. 2, Feb. 90 pp 112-115

[Text]

O. Introduction

Flexible automation of small and medium batch manufacturing in the metal-working industry requires automatic process monitoring to insure the required productivity, flexibility, precision and reliability. The requirements on the performance of such monitoring solutions continue to grow [1] as, in the international development trend, more and more plants convert to manufacturing without any or with only a minimum of operator intervention by implementing a CIM operation using powerful key technologies.

1.Problem

A number of metal-cutting tools with an even larger number of blades are in use in flexible manufacturing systems. These are to be automatically monitored for tool wear and tool fracture. The variety of designs of cutting tools used and the different requirements of various monitoring strategies (tool changing, wear compensation, processing optimization) make tool monitoring difficult. As a part of process monitoring, tool monitoring is receiving a dominant role [2]. The nucleus of the tool monitoring system is the cutting quality with the criteria of tool wear and tool fracture [3]. For economic reasons, the maximum universal application and flexibility of the monitoring device are necessary to ensure the required tool monitoring in the manufacturing system with the fewest sensors possible [3]. In accordance with the great importance attached to tool wear monitoring for a CIM plant, the dramatic development of sensor research continues worldwide. Resulting from this development, besides a variety of pilot solutions, a complete range of wear measuring systems has been applied in industrial manufacturing practice [3]. One weak point is the powerful wear monitoring systems

for prism part processing that allow a reliable, sufficiently precise and economically feasible wear monitoring of rotating multi-blade milling cutters and boring tools and that have proven themselves in rugged industrial applications in a flexible manufacturing system [3]. Up to now, optical or opto-electronic monitoring systems have been developed for this purpose. However, these systems are relatively expensive, prone to failures and have very specific operating conditions. An alternative to these systems is an electronic contact sensor system presented in the following.

2.Principle of the Operation of the Electro-Contact Wear Sensor System

In this sensor type, the contact touching a tool blade to be monitored with a measured value pickup of the sensor is used to produce an electrical signal and thus to identify the current state of wear. These types of sensor solutions operate relatively reliably and can be implemented at a reasonable cost. One large disadvantage is the wear of the measured value pickup attached to the contact. For this reason, a sensor solution was developed that does not exhibit this disadvantage. A reliable electric contact touching is ensured by way of a defined chip removal system on the sampling electrode of the measured value pickup [4]. Fig. 1 illustrates this type of measuring voltage for measuring wear. The current contact of the moving tool blade 3 with the scanning electrode 1 is interrupted by the insulating layer 2 having width b_0. During formation of a wear land value VB_N on the slope of the side rake, the circuit interruption of the insulating layer is shortened by VB_N to a gap width of b_V. The implementation of this measuring principle requires a suitable selection of material for the scanning electrode 1 and the insulation layer 2 so that a cutting burr is not created or does not elongate the electrode contact beyond the insulating gap thereby imitating wear [4].

Designations	
I	Pulse count
K	Constant for frequency measurement in 1/mm
R	Nominal tool radius in mm
b	Width of the insulator layer in mm
f	Measurement frequency, pulse frequency in 1/s
n	Rotational speed in rpm
t	Time; contact time interrupt in ms
v	Peripheral speed in mm/s
z	Cutting number
φ	Angle of rotation of the tool blade in °
ω	Angular speed in °/ms
SKV	Backward offset of cutting edge
VB	Wear land value

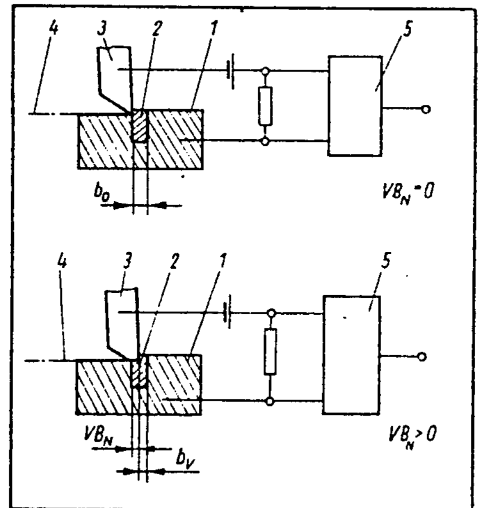

Fig. 1 Principle for measuring cutting blade wear according to the electrical contact sensor for sharp and worn tool cutting blades.

Key: 1—Scanning Electrode; 2—Insulating Layer; 3—Tool Cutting Blade; 4—Relative Path of Motion; 5—Evaluation Device.

Indices	
Limit	Limit value
M	Measured, referenced to measurement
N	Side rake
O	Referenced to the measurement gap
V	As a function of wear
VB	As a function of the wear land
i	Index variable
m	Average
max	Maximum
min	Minimum

3. Measuring Signal, Measured Variable, Measurement Geometry

For tool cutting edges moving in a straight line, the wear land value VB_N results from $VB_N = b_0 - b_V$ (1)

In the case of rotating tool cutting blades, the contact is interrupted along the circular path of the tool cutting blades. It can be seen in Fig. 2 that a sharp blade over b_0 requires a contact interrupt angle φ_0 and cutting blade worn by VB_N requires a contact interrupt angle φ_V that is a function of wear.

For the wear land value VB_N, the display angle φ_{VB} comes from $\varphi_{VB} = \varphi_0 - \varphi_V$ (2)

Eq. (2), when multiplied by R as one-half the nominal tool diameter, results in $\varphi_{VB}R = (\varphi_0 R) - (\varphi_V R)$ (3)

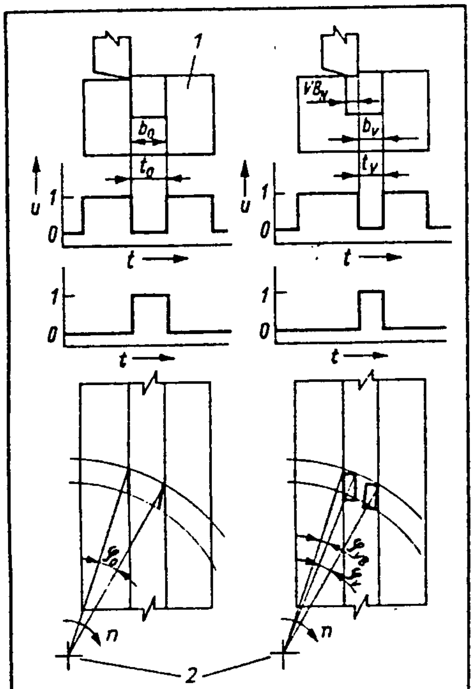

Fig. 2 Generating the measured signal $VB_N = f(t)$ by means of an electric contact sensor (for an idealized wear land value VB_N).

Key: 1—Sensor Work Piece; 2—Tool Center.

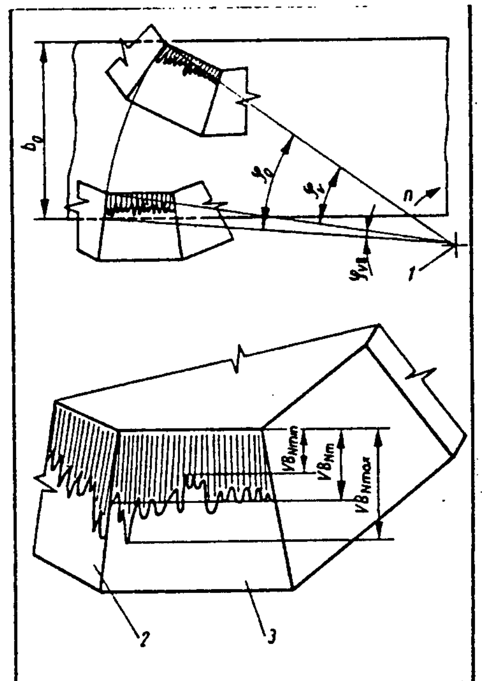

Fig. 3 Measuring Geometry for End Milling

Key: 1.—Tool Center; 2.—Main Cutting Edge; 3.—Side Rake.

$\varphi_{VB} R = VB_N$

$\varphi_0 R = b_0$ (5)

Eq. (4) and Eq. (5), when substituted in Eq. (3), result in the following, similar to Eq. (1): $VB_N = b_0 - (\varphi_V R)$ (6)

As a simplification, the cutting blade wear shown in Fig. 2 was idealized as a rectangular area. Closer to reality when compared to this is a real state of wear as shown in principle in Fig. 3. Here, a cutting blade worn by VB_N is shown over the measuring gap b_0 in the measurement geometry characteristic for end milling. This gap constantly determines the largest wear land, longest in the direction in motion, specifying the interruption φ_V of the electrical contact of the cutting edge with the scanning electrode. Thus, according to the electrical contact measuring principle, the maximum wear land value VB_Nmax of the side rake slope is always measured. The measuring geometry for boring is shown in Fig. 4. With regard to the cutting edge, the measured value is obtained in a similar fashion for end milling but orthogonal to the measuring gap. As the working planes of end milling and boring are also orthogonal to one another, one scanning electrode with measuring cap can be used for wear measurements of both processing groups.

Wear is measured for each tool with the constant spindle speed n where $\omega = \pi n/30$ (7)

and

$t = \varphi/\omega$ (8)

According to Eq. (8), Eq. (2), divided by Eq. (7), yields: $t_V B = t_0 - t_V$ (9)

The time of the interruption of the electrode contact from the cutting edge and the scanning electrode by the insulating measuring gap is measured by means of digitalization of the time increments according to Eq. (9) with the help of a measuring frequency f. In a time period t, a number of pulses I is generated with a frequency f where the following applies:

$I = tf$ (10)

Eq. (10), applied to Eq. (9), yields

$I_{VB} = I_0 - I_V$ (11)

According to Eq. (10), the following holds

$I_V = t_V f$ (12)

and according to Eq. (8)

$t_V = \varphi_V/\omega$ (13)

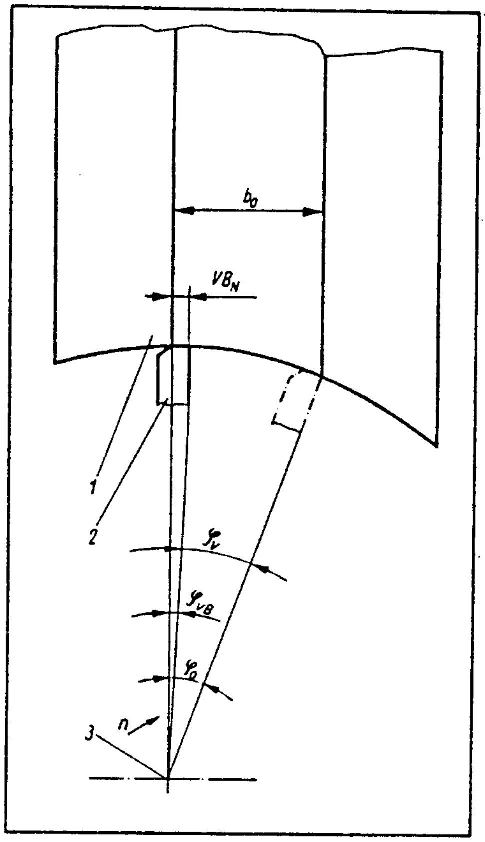

Fig. 4 Measuring Geometry for Boring.
Key:— 1. Sensor Work Piece with Insulating Gap b_0—2. Boring Cutting Edge—3. Tool Center.

Eq. (12) and Eq. (13), substituted into Eq. (11), yield

$I_{VB} = I_0 - (\varphi_V f/\omega)$ (14)

With the peripheral speed v of the cutting edge, the following holds

$\omega = v/R$ (15)

From Eq. (6) follows $\varphi_V R = b_0 - VB_N$ (16)

Eq. (15) and Eq. (16), substituted into Eq. (14), yield

$I_{VB} = I_0 - (b_0 - VB_N) f/v$ (17)

Zero offset: With a sharp cutting edge, $VB_N = 0$. Substituting these values in Eq. (17) yields the following for

I_0 $I_0 = b_0 f/v$ (18)

From Eq. (18), it can be seen that with a correction factor K and the following specification

$f = vK$ (19)

the following results

$I_0 = Kb_0$ (20)

With a suitable selection of f with respect to v, K can be specified such that I_0 is the same in numerical terms as b_0. In this way, VB_N can be directly represented digitally as a numerical value (in millimeters).

4. Measured Value Processing and Evaluation Strategy

The evaluation device according to Fig. 1 has the task of determining the contact time interruption t_V as a function of wear for each tool cutting edge to be monitored during removal of the chips at the scanning electrode. To this end, the device is brought into measuring position with respect to the tool cutting edges to be measured by approaching during a pause in the work by way of the NC axes. Fig. 5 shows this situation during end milling with an inserted blade milling cutter. In this manner, the scanning electrode has the character of a "sensor work piece" as a measurement voltage occurs to measure the wear. The wearing part of the scanning electrode makes very many wear measurements possible as a result of the very low measuring voltage. The scanning electrode is inexpensive and can be easily replaced with a new scanning electrode. In spite of this, the number of measurements and the time for replacement should be optimized according to a measuring strategy. As can be seen in Fig. 5, the scanning electrode is mounted in the work space of the machine tool and mounted to this tool so as to be electrically insulated from it. A voltage of 5V is used for the measurements. Coolants and lubricants impair the measured value pickup only to a small degree. Blowing on the scanning electrode with compressed air has a favorable effect for eliminating impurities. Being worn by VB_N, the reversing cutting plate of the FPX inserted blade milling cutter of Fig. 5 generates an interruption in the contact path $\varphi_V R$ when cutting over the measuring gap b_0 of the scanning electrode according to Eq. (16), said interruption corresponding to a break in the contact time t_V according to Eq. (13). This is digitized in an evaluation device, such as shown in Fig. 6, using a pulse frequency f according Eq. (19). The pulse number I_V according to Eq. (12) is created as the result according to the following equation:

$I_V = (b_0 - VB_N) f/v$ (21)

Together with Eq. (11), this results in Eq. (17). According to this equation, the pulse number I_{VB} representing the wear VB_N is calculated in the evaluation device and digitally displayed as the VB_N value in mm or made available to the wear computer for further processing. This process can be performed for any number of measurements—preselected as an event number on the wear measuring unit. Fig. 7 shows the block diagram of the wear measuring unit. According to this diagram, all input measured values I_V are subtracted from I_0 and stored for further processing. A special circuit insures that, in the case of several measurements for one cutting blade, VB_{Nmax} is always selected and displayed.

Fig. 6 Wear measuring unit for an electric contact sensor. Event: (z x U_M) measurements preset switch Address: Cutting blade z_i preset switch Gap width: b_0 in mm

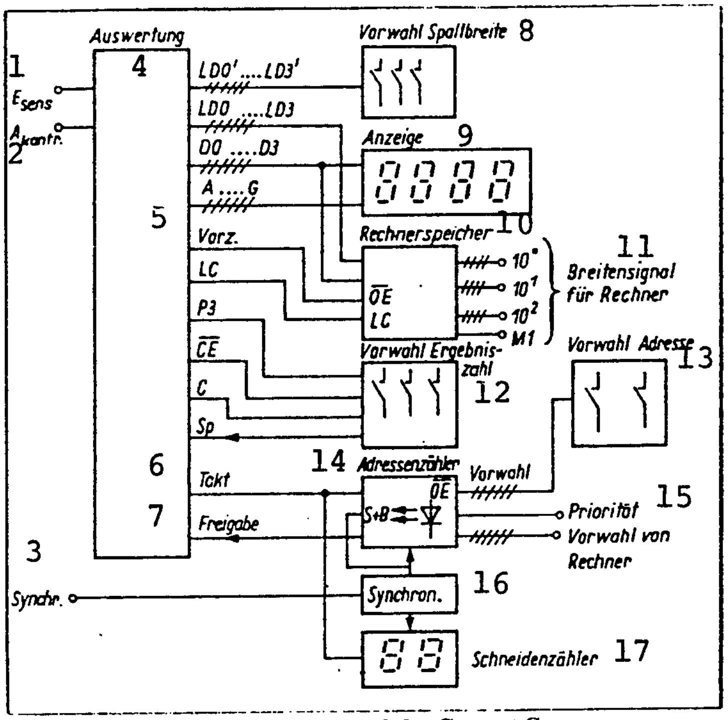

Fig. 7. Block Diagram of the Contact Sensor.

Key:—1 I_{sensor}—2. $O_{control}$—3. Sync—4. Evaluation—5. Sign—6. Clock—7. Enable—8. Preset Gap Width—9. Display—10. Computer Memory—11. Width Signal for Computer—12. Preset Result Number—13. Preset Address—14. Preset Address Counter—15. Priority Preset from Computer—16. Synchronization—17. Cutting Edge Counter

preset switch VB: Digital display for VB_N in mm Number: Digital display of contact cutting edge number z_M Measurement type: "Individual/Total" preset switch Priority computer: LED display for computer control mode of operation V_z "-": LED indicator for $VB_N > b_0$ Syn.: Synchronizing signal input Input: Wear measuring signal input Output: Measuring signal check output

In the case of multi-blade tools, VB_{Nmax} of the sharpest blade i.e. min VB_{Nmax} by way of a selected measurement—designated as the measurement mode "Total"—is determined. In the case of finishing tools, the value Min VB_{Nmax} for a computational determination of the backward offset of the cutting edge SKV can be used in order to provide it as the infeed value of the machine control system for wear compensation. By means of an additional module for the evaluation device, a mean or maximum value can be determined for multi-blade tools from the VB_{Nmax} value measured for each cutting edge. This value can then be sent to the computer for further processing. By means of a defined measuring cutting depth (corresponding to the required tool setting precision), a reliable contact with all cutting edges can be made for every tool newly introduced into or properly preset in a machine system. All tools with cutting edges that are sharp were detected as being correct by way of the cutting edge setting check. During all wear measurements at later times, they can be checked for cutting edge fracture. The contact making cutting edge number is displayed on the wear measuring unit of Fig. 6 as "Number". This fracture detection is particularly important for finishing operations because these types of finishing fractures cannot usually be detected by way of indirect measuring methods used by an in-process fracture detection system. Table 1 shows the wear sensor monitoring system.

Table 1 Monitoring tasks and signal evaluation in the wear measuring unit using electric contact sensors

Wear measuring device	Control computer for wear measurement
1. Cutting edge setting check	
Determine z_M/rotation with a sharp tool	Logical comparison: $z_M = z$: tool OK; $z_M < z$: tool reduction
2. Cutting edge fracture check	
Determine z_M/rotation for one tool that has already cut	Logical comparison: a) Finishing tool $z_M < z$: change/replace tool b) Roughing tool (z - 2 < z_M < z: more frequent measurement; z_M < (z - 2): replace/change tool

Table 1 Monitoring tasks and signal evaluation in the wear measuring unit using electric contact sensors (Continued)

3. Tool wear measurement	
3.1. Individual cutting blade measurement	
Determine VB_{Nmax} of the preset cutting edge z_i	Preset the gap width b_0; set the measurement mode "Individual"; preset the cutting blade address z_i:—limit comparison VB_{Nmax} >= VB_{Nmax} limit => change/replace tool,—storing of the individual measured values,—calculation VB_{Nmax}—mean VB_{Nmax}—maximum;—wear progress analysis
3.2. Selective multi-blade measurements	
Determine min VB_{Nmax}	Set the measurement mode "Total", preset one event number (zU_M): a) Roughing tool, limit comparison, mean VB_{Nmax} >= min $VB_{Nmaxlimit}$ = change/replace tool ; b) Finishing tool, conversion from min VB_{Nmax} into min SKV and transmission of the value to the machine control system

5. Testing, Application

The described sensor system was tested as a pilot solution, an industrial application is planned. The accuracy of the measurement for VB_N can be assumed to be +/- 0.02 mm [3]. By means of the use of the wear sensor system, sufficiently precise measured wear values can be obtained from the metal- cutting process. These values can detect the existing wear behavior in order to update an externally specified service life and to make internal processing optimization possible. A tool monitoring system including the described cutting edge quality monitoring system makes possible timely tool change, wear compensation and economical utilization of cutting materials thereby increasing productivity, reliability and accuracy in the manufacturing process. The advantages of the wear sensor system described justify use in processing centers and flexible manufacturing systems. Fig. 8 shows the use, in principle, of the wear measuring device in conjunction with a wear computer. The connection to the control computer and into the machine control system is established by way of this wear computer. The sensor system can even be inexpensively retro fitted to existing NC machine tools as a rationalization solution. A universal application as a measuring unit in research laboratories is possible for the tool, metal-cutting and wear research fields.

6. Summary The wear sensor system for monitoring cutting quality of milling, drilling and boring tools represents a robust, inexpensive and precise monitoring solution suitable for industrial use. Particular advantages are:

- The possibility of multiple measurements as a result of a rotating spindle and thus preset increase in accuracy and reliability.
- Less susceptible to interference with respect to impurities when compared to SKV scanning using a feeler.
- Measurement of VB_N is more precise as VB_N >> SKV.

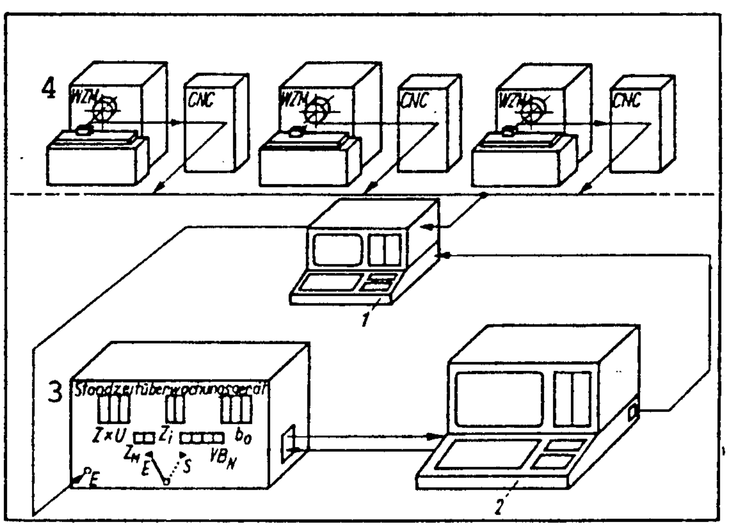

Fig. 8. Monitoring of the cutting quality in a flexible manufacturing system

Key: 1. Control Computer—2. Computer/wear Measurements—3. Service Life Monitor—4. Machine Tool

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Flexible Assembly System Described

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[Text] 0. Introduction In industrial production, assembly work engages a high percentage of the workforce potential. For this reason, the mechanization and automation of manual assembly operations is in the center of rationalization efforts internationally. A substantial focal point of investment is in mechanical-engineering measures. While special-purpose machines and devices are used for mass-production assembly, the ability of the assembly machinery to adapt (flexibility) to various operations, parts and tools is practical for small batches of a product class for economic reasons. Automatic assembly centers have been constructed using commercially available industrial robots (IR) that can be equipped with corresponding assembly grippers and tools, changing systems and sensor units, together with appropriate peripheral devices such as storage facilities, loading bays for assembly parts and tools, and assembly presses [1]. These assembly centers represent the economical solution for many automation projects in coming years. If the IR have not been specially designed as assembly robots [2], they have poor manipulation/power ratios, i.e., large masses need to be moved with a few kW of drive power to position relatively lightweight assembly parts. To achieve shorter cycle times, more refined assembly sequences primarily must be found and assembly tools, multi-part grippers and other flexible devices are to be used. These measures save the coarse movements of the manipulator units or make the time-consuming use of a press unnecessary. The following describes modular building blocks that, when combined, form automatic assembly cells with assembly arms and assembly hands, and are designed for complicated assembly operations in flexible automatic assembly systems (FAMS). With these developments, the research group of the authors has pursued its previously presented and described tendency of an appropriate mechanical-engineering design for FAMS [3] (Fig. 1).

The practical applications and the flexibility of the building blocks are described by way of the automatic assembly of a compressor valve. Assembly takes place in a prototype assembly cell [4] designed as the first part of a FAMS according to Fig. 1. That is a cell that can be expanded in different directions spatially and can be connected to a transport system. The results of previous developments are discussed in the research works.

1. Frame and motion units A flexible assembly cell has at least one assembly hand [7], flange-mounted on an assembly arm. The assembly arm moves the assembly hand in the work space in accordance with the technological requirements following a program. According to the design of Fig. 1, a surface gantry with three axes of translation (motion units) X, Y and Z was selected as a structure favorable for use in assembly cells. Among others, the advantages of this arrangement consist of the following:

- that the work space can be reached from three sides without impediment and is visibly delimited;
- that the linear motion units can be controlled simply; and
- that the mass of the motion units X and Y is supported by the frame and thus gravity acts only on the drive of the Z axis.

Fig. 2 shows a computer graphic illustration, produced by the GEDA program [5], of the motion units with the frame.

The frame of the prototype assembly cell (Fig. 8) consists of lightweight steel sections that are connected to one another by means of screws or clamps so that they are adjustable. Each of the three motion units is equipped with a drive unit consisting of a 200W dc motor with a following adjustable worm drive. An angular position measuring system and a tacho-generator are coupled to the open ends of the shaft of the positioning motors. The WSAZ-DGA module with transistorized TPS 20A pulsed final controlling elements from the VEB NUMERIK "KARL MARX" are used to control the motor speed. A K1520 microcomputer is used to control the axis positions. This computer processes the measured angles in a time-multiplexed fashion, compares them to the desired positions specified by the control computer and outputs the reference variables for the rotational speed control circuit by way of a digital-analog converter. The drive rotational motion is converted into a linear motion in the case of the X and Y axes using a toothed-belt drive and in the case of the Z axis by means of a rack and pinion. The permissible manipulation mass is 35 kg. The positioning accuracy of the X and Y axes is

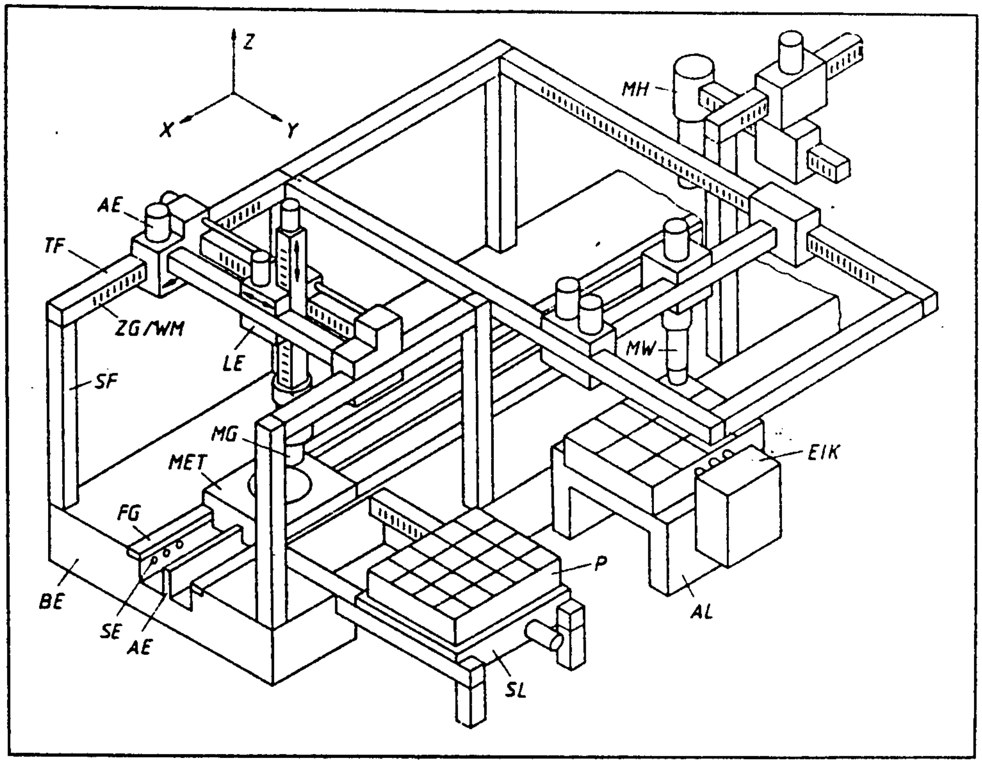

Fig. 1 Mechanical-engineering components of a modular assembly system. BE basic element; FG guides for MET the assembly unit—supports of the interior transport system; SE control elements; SF support elements and TF bearer elements of the LE linear units with CG rack and pinion or drawing drive and WM distance measuring system. MG assembly gripper; MW assembly tool; MH assembly hand (previously the assembly heads); P palettes, some in the Al storage facility with the EIK energy-information coupling system that can be reached by the active assembly tool or storage elements by way of SL sleds.

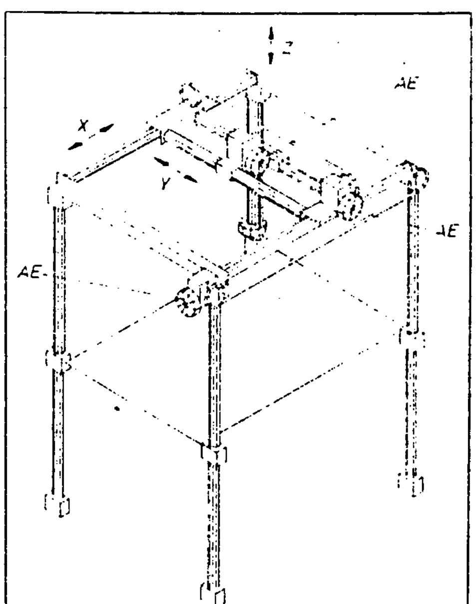

Fig. 2. Frame with motion units. AE drive units for motion in the X, Y and Z directions.

better than +/- 0.25 mm, the maximum rate of motion is 1 m/s. The positioning accuracy of the Z axis is +/- 0.05 mm and its maximum rate of motion is 0.2 m/s. A height-adjustable table is located inside the frame. This table is used to accommodate one or more palettes holding tools and assembly parts. The modular design easily allows changing the size and connecting several frames.

2. Assembly hands Assembly hands (Fig. 3) consist of different modular building blocks that must replace the abilities and skills of a human during automatic assembly [6]. The assembly hands can be adapted to the assembly task by means of various combinations of the building blocks. A few of the modular building blocks developed for assembly hands at the Technical University of Karl-Marx- Stadt, Machine Component Section, are introduced in the following, said blocks being one part of the flexible assembly cell.

2.1 *Sensor unit* The sensor unit is indispensable in flexible assembly automation for monitoring and limiting forces in the assembly direction as well as moments about the assembly axis and to compensate for position and angle deviations. The unit consists of sensor modules in which the monitoring and limiting functions as

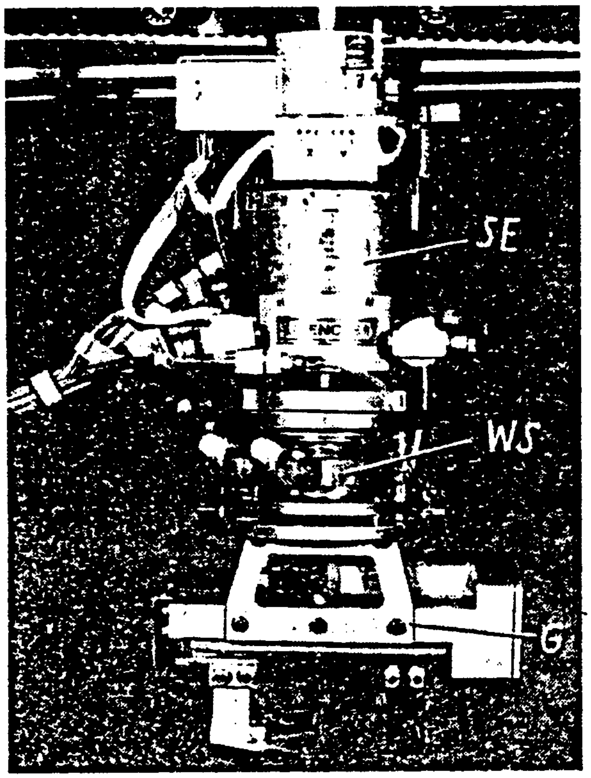

Fig. 3 Assembly hand. SE senor unit WS changing system; G gripper.

well as the compensation and correction functions are logically separated so that superposition of the individual axial measured values and expensive computer/electronic decoupling of the measured values of the axes are not necessary. The specially selected arrangement of elastic limbs provides the advantage that adaptation of these limbs to this assembly task is not necessary. The sensor modules can, for this reason, be arranged as fixed components of the assembly hand, e.g. above the changing system. Additional elastic limbs, such as those of the previously customary uncontrolled assembly mechanisms (UFM) [6] are not necessary. The rigidity of the sensor modules can be changed using compressed air.

2.2 *Changing system* To be able to adapt the assembly hand to various tasks, a device for automatically changing grippers or tools is needed. The automatic changing system shown in Fig. 3 is characterized by a simple and robust construction [8]. Providing exact positioning and orientation of the grippers and tools, the system provides for absorption and transmission of forces and moments. To do this, the building blocks to be changed must be equipped with a standard connecting flange. The required transmission of data and pneumatic and electrical energy is insured by way of plug connectors. The building blocks are fixed in position using a pneumatic operating cylinder. To reliably disconnect the grippers or tools, a pneumatic separation aid is used. This aid prevents impermissible loading of the assembly arm and reduces the expenditure for the gripper magazine.

2.3 *Flexible gripper* The flexibility of an automatic assembly machine is essentially determined by the grippers used. In many cases, special grippers are used that can be coupled to an automatic changing system on the assembly arm depending upon the assembly task. Another possibility is the use of a flexible gripper that can be adapted to the technological parameters of interest within broad limits. In this way, gripper change time can be saved and the expenditure to develop and manufacture a number of special grippers is reduced. Fig. 3 depicts a flexible gripper as the modular building block of the assembly hand. The gripper is driven by a precision miniature motor. The gripper gear unit consist of a two-stage spur-gear unit and a sliding screw gear unit. The gripping elements can be changed easily and are designed so that they are suitable for gripping various objects. The gripper can be controlled by computer by way of an electronic connection module. In this way, the maximum gripping force can be set and the opening size of the gripper elements is programmable. Programming is done by example where the opening size achieved by the gripper is stored when grasping the appropriate part. In automatic operation, the stored data are used to set practically the gripping element and to check for the presence of the parts used in the assembly process [8]. The gripper can be used as an interior or exterior gripper for rotationally symmetric and prismatic parts when the gripping elements are designed appropriately. Due to the ability to preset its gripping elements, the gripper can remove parts from densely populated palettes and perform assembly operations in a very small space.

2.4 *Assembly tool with impact effect* Assembly parts having transition and force fits require forces that cannot be produced by assembly arms as a rule. This results in the situation that a press station to which the parts must be transported from the manipulator becomes necessary. By using an assembly tool with impact effect that can be coupled to the assembly hand, the use of the press is not necessary thereby saving both space in the work area of the manipulator as well as time in the assembly cycle [9]. The assembly tool (Fig. 4) produces a sequence of individual blows similar to a jack hammer by means of an internal pneumatic control system. These blows are transferred to the part to be mounted by means of an impact piece S. In this operation, the impact piece also serves as a gripper for the assembly part. The impact reaction on the assembly hand is damped by, among other measures, elastomer springs EF.

Presses having a force up to 20 kN can be replaced with this assembly tool. The impact frequency ranges from 20 to 45 Hz. To design the assembly tool and to adapt it to the required assembly force range, a computer program is available at the Machine Component Section of the

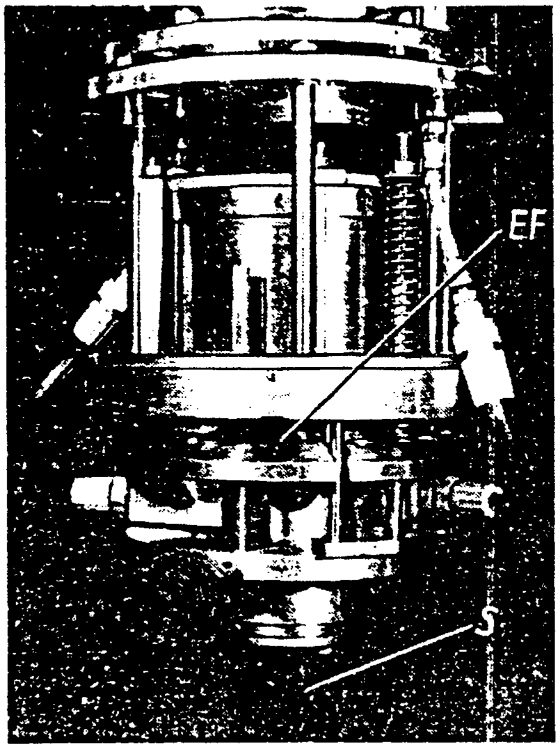

Fig. 4. Assembly tool with impact effect. EF elastomer

Technical University of Karl-Marx-Stadt [10]. A further developed assembly tool is currently undergoing testing.

2.5. *Screw unit* The screw unit makes automatic production of screw connections possible within the assembly cell. The building block is arranged as a second assembly hand beneath the assembly table so as not to restrict the range of operation of the assembly arm (Fig. 5). A three-phase gearmotor M is used as the drive element.

A torque measuring shaft DMW is located between this gearmotor and the screw tool SW. In conjunction with a measured-value pickup, this shaft forms a torque measuring device. A compensation device in the form of a double slider coupling (an Oldham coupling) serves to compensate position deviations between the assembly parts at right angles to the screw axis. This coupling is located between the screw tool and a wrench S used for counterpoise. A hardware module was developed to control the screw unit. This module is connected to the control computer by way of a parallel port. The signal for switching the motor on is output by the control computer. The signal for switching the motor off comes from the torque measuring device when the preset torque value is reached. During the screw operation, the number of motor rotations is counted and then the counter result is evaluated in the control computer. In this way, incorrect screw connections can be detected.

3. *Controlling and programming the assembly cell* A two-computer system is used to control the flexible assembly cell. This system consists of a K1520 microcomputer and a A5120 office computer. The K1520 implements the position control for the three motion units. This also includes processing the sensor signals from the assembly hand. The A5120 functions as the control computer, i.e. it makes it possible to operate the assembly cell, to program and monitor the assembly process, and to store and test the assembly programs. Programming and operation of the assembly cell is performed interactively. It is not necessary to learn a programming language. In addition to the motion units, the functions of all system components of the assembly cell can be programmed or executed by way of the keyboard of the A5120. This is done by pressing specific keys according to the displays of the screen menu. The positions of the assembly hand in the work space of the assembly cell are programmed very simply using the joy stick of the teach-in manual control device (Fig. 6). The teach-in programming is substantially supported by the monitoring and compensation functions of the sensor unit of the assembly hand. [Fig. 6 not reproduced]

4. *Current assembly task* At this time, compressor valves (Fig. 7) are being automatically assembled in the assembly cell in laboratory operation. To reduce the expenditure for automatic assembly of the assembly

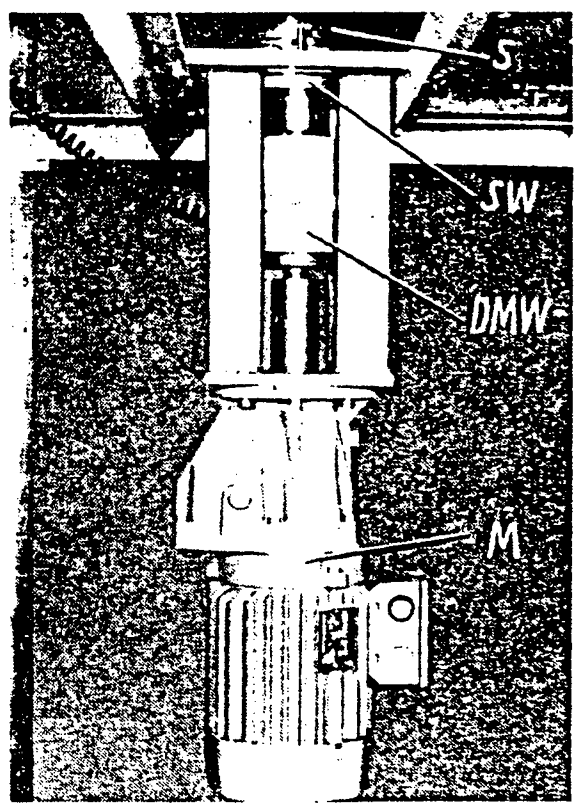

Fig. 5 Screw unit. S wrench; SW screw tool; DMW torque measuring shaft; M motor.

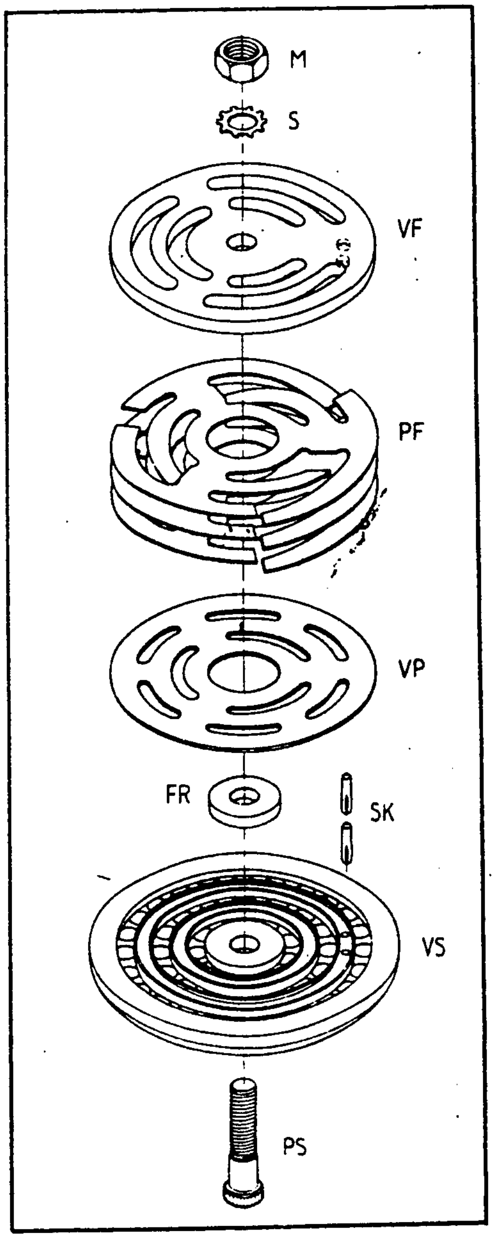

Fig. 7. Compressor valve. M nut; S fan washer; VF valve guard; PF plate springs; VP valve plate; FR guide ring; SK notched pins; VS valve seat; PS precision bolt.

unit, changes were made to improve the assembly suitability in the form of chamfering and centering shoulders to the assembly parts of the precision bolt, the valve seat, the guide ring and the valve guard. The individual parts of the valve were positioned and, in the oriented position, made available in magazines.

The assembly operation begins with mounting the gripper in the changing system. With this, the precision bolt and the valve seat are inserted into the assembly device one after another. Then, the gripper is changed for the assembly tool with impact effect which produces the press fittings of the valve seat/precision bolt and the valve seat/notched pins. The notched pins are also fed using the assembly tool using a gripper contained in the impact piece. In this way, an additional changing operation can be avoided. After another change of the assembly tool for the gripper, the guide ring, valve plate, valve spring, valve guard and an auxiliary ring for centering the valve parts are assembled. The module created is then removed from the assembly device and placed on the screw unit. Subsequently, the gripper picks up a tool in which the fan washers and the nuts are stored and that is also used as a counterpoise during the screw operation. The fan washer and the nuts are each fed to the precision bolt by a wiping motion. Then, the tool, now being used as a socket wrench, is placed on the module. After screwing the module, the tool is removed again and the finished valve is ejected through the auxiliary ring.

5. *Summary* The mechanization and automation of assembly processes are economically necessary and becoming more and more technically possible. In this respect, technical systems that are flexible, i.e., adaptable to various assembly task, are necessary particularly in small-batch and medium-batch manufacturing. The Machine Component Section of the Technical University of Karl- Marx-Stadt has been working continuously for years on the development of modular building blocks for automatic assembly. The combination possibilities of these building blocks makes possible the mechanization and automation of a number of assembly operations. At present, the prototype of a flexible assembly cell (Fig. 8) is undergoing testing. This cell can be used both individually and as a component of a flexible automatic assembly system. Its current design is determined by the assembly operations required to automatically assemble compressor valves.

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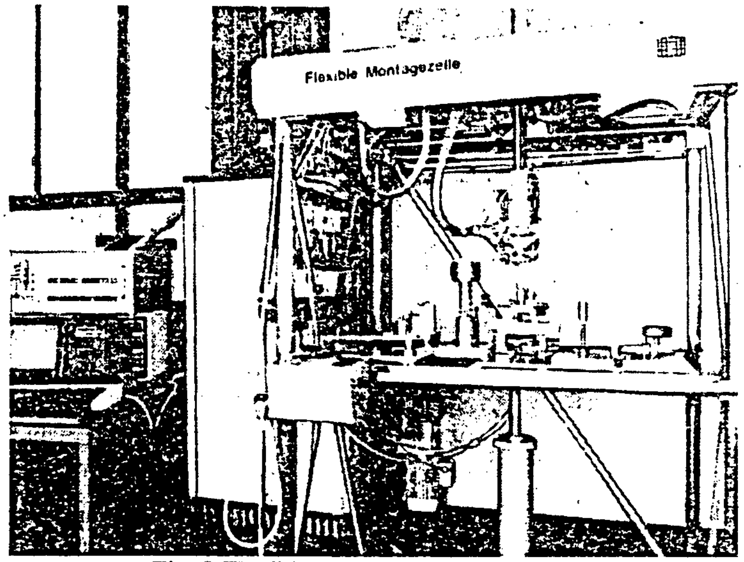

Fig. 8 Flexible assembly cell.

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LASERS, SENSORS, OPTICS

CSSR: Force Sensor with Optical Fiber Waveguide Developed

90CW0178A Prague STROJIRENSTVI in Slovak No 12, Dec 89 pp 720-724

[Article by Eng P. Skok, ScC, Chair of Instrumental and Automation Technology, SjF Institute of Technology in Kosice, Presov branch, Eng T. Herbst, Slovnaft National Enterprise in Vojany, and Eng P. Hajtol, Kovoprojekta Enterprise in Presov: "Construction of Force Sensor with Optical Fiber Waveguide"]

[Text] The authors describe the construction of force sensor using fiber waveguide, its realization and application in industrial robots. The sensor is able to transmit light energy to relatively long distances with very small losses. It is appropriately sensitive and resistant to electromagnetic interferences, temperature and chemically deleterious environment. Because diameters of optical waveguides are very small, the demands on their deployment and bulk are minimal.

Introduction

The interest in the development and application of sensors with optical fiber waveguide (optical fiber sensors - OVS) has rapidly increased in recent years because of several advantages of the OVSs as compared with conventional sensors: higher sensitivity; resistance to electromagnetic interference, temperature and harmfulenvironment; a common technological base for sensors of different physical parameters; and geometrical adaptability of structures of sensors with different shapes. It should be noted that OVSs of nearly all physical parameters (pressure, temperature, force, velocity, acceleration, displacement, electric and magnetic fields,etc) have been developed. An overview of the developed OVS's appears in literature.[1, 2, 3, 4] In terms of the principle of their development, the OVS's may be divided into extrinsic and intrinsic. In extrinsic OVS's the optical fiber waveguide is used only as an input-output componentof the optic signal modulated by the scanned physical input. In intrinsic OVSs the scanned input affects some of the parameters of radiation spread by the waveguide: amplitude (intensity), phase, polarization, and wavelength. Fig. 1 presents a block diagram of intrinsic OVSs.

In terms of design OVSs with amplitude modulation are the simplest; they require no sophisticated equipment to

record changes of the optical signal, as is the case, for instance, of the OVSs with phase modulation.

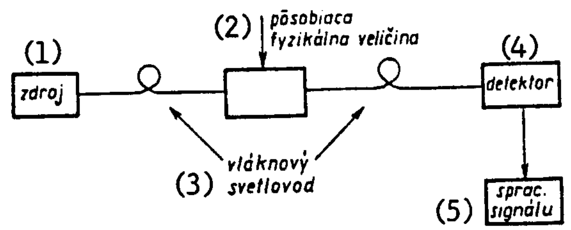


Fig. 1. Block Diagram of an Intrinsic OVS

Key: —1. Source—2. Applied physical quantity—3. Optical fiber waveguide—4. Detector—5. Processing of signals

A photodetector attached to the terminal of the waveguide suffices for the recording of changes of the amplitude (intensity). In mostcases LED (emitting usually in the infrared zone) serves as a source of optical radiation tuned in the waveguide. Their simplicity and relatively low price predetermined the amplitude OVSs for industrial use.

2. The Principle of Function

There are several methods to design sensors of with amplitude (intensity) modulation. The simplest method involves the splitting-up of the waveguide; here the force acting on one end of the waveguide moves it toward the other end. Consequently, there is change in the intensity of radiation tuned in the part of the waveguide containing the photodetector.

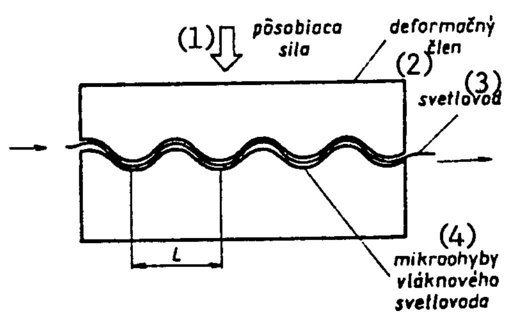


Fig. 2. Deformation Component for Inducing Microrefractions of a Optical Fiber Waveguide.

Key: —1. Acting force—2. Deformation component—3. Waveguide—4. Mictorefractions of the fiber optical waveguide

Another, more sensitive method concerns the creation of periodical microrefractions in a small section of the optical fiber waveguide.The waveguide is inserted between two parts of the deformation component with an appropriate periodic structure. The scanned force induces mutual shifts of parts of the deformation component, which results in the development of microrefractions of the waveguide in the periodic structure (Fig. 2).

Due to the development of the microrefractions, there is a change in the coefficient of the coupling between the carried and emitted modes of the multimode waveguide. Modes of higher orders are diffused on periodic microrefractions, which changes the intensity of light radiation spread by the waveguide. Theory [1] indicates that the coupling between the carried and emitted modes is at the highest when the difference between the constants of the spread of these modes equals $2\pi/L$, where L is the spatial wavelength of the periodic structure (the distance between two peaks). For modes with constants of spread β and β', the highest coupling takes place if: From the

$$\beta - \beta' = \frac{2\pi}{L}. \tag{1}$$

theory of mode spread by optical fiber waveguide (for example [5]) it follows that for waveguides with a parabolic profile of the refractive index of the core, difference $\delta\beta$ between the constants of mode spread is equal to

$$\delta\beta = \frac{\sqrt{2\Delta}}{a} \tag{2}$$

and for waveguides with constant refractive index of the core it is equal to:

$$\delta\beta = \frac{2\sqrt{\Delta}}{a}\frac{m}{M}, \tag{3}$$

where α is radius of the core, Δ is relative difference betweenrefractive indexes of coating n_2 and core n_1 (center of the core in parabolic profile),

$$\Delta = \frac{n_1 - n_2}{n_1},$$

m is the selected mode, and M is the number of feeder modes. Thus, for waveguides with parabolic profile of the refractive index of the core, spatial wavelength of periodic structure is expressed by relation

$$L = \frac{2\pi a}{\sqrt{2\Delta}} \tag{4}$$

and for waveguides with constant refractive index of the core

$$L = \frac{\pi a}{\sqrt{\Delta}}\frac{M}{m}. \tag{5}$$

Waveguides with parabolic profile of the refractive index of the core have spatial wavelength of microrefractions for optimum coupling between modes, which is not the case of waveguides with constant refractive index of the

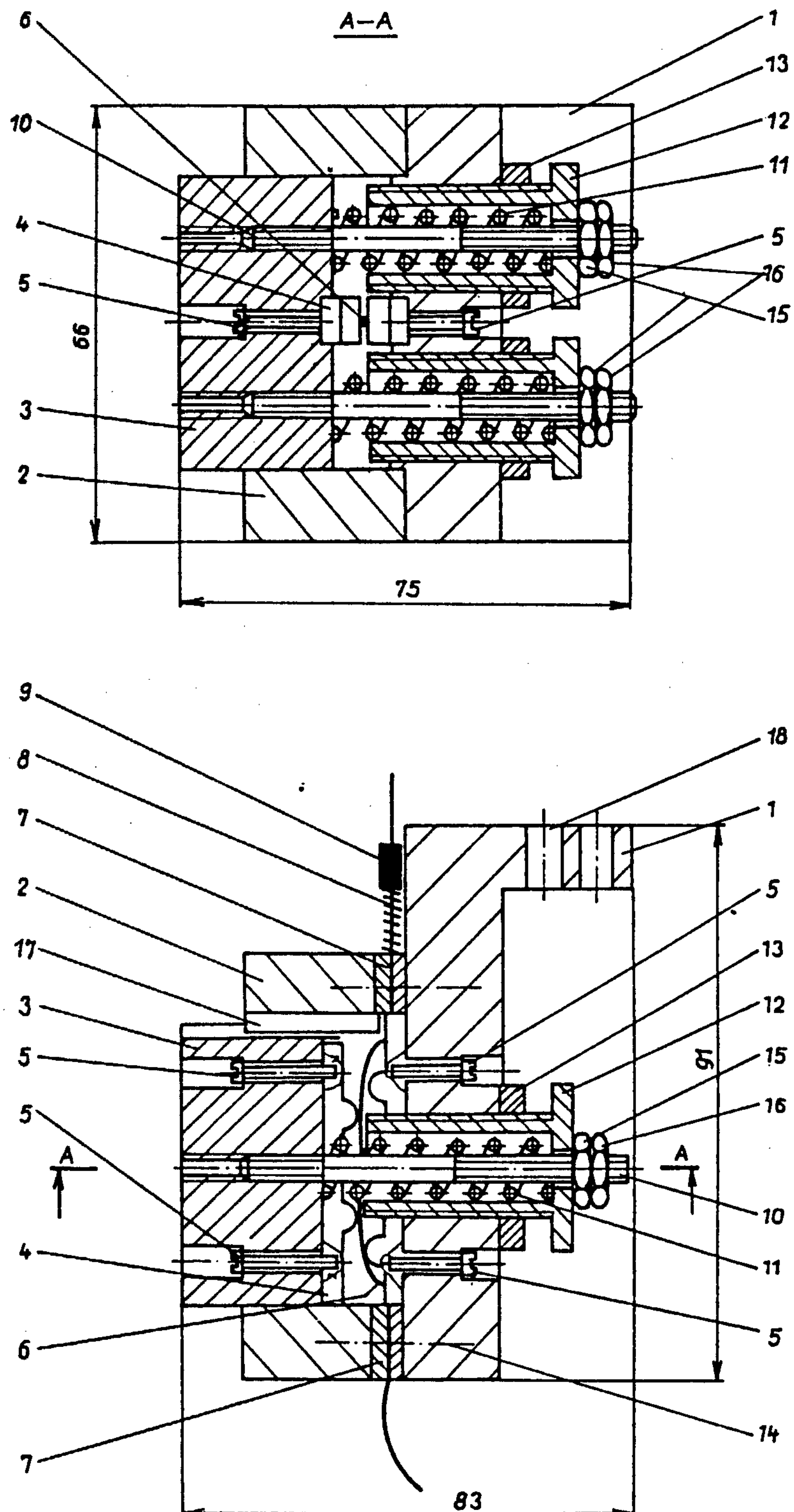


Fig. 3. Construction of a Sensor

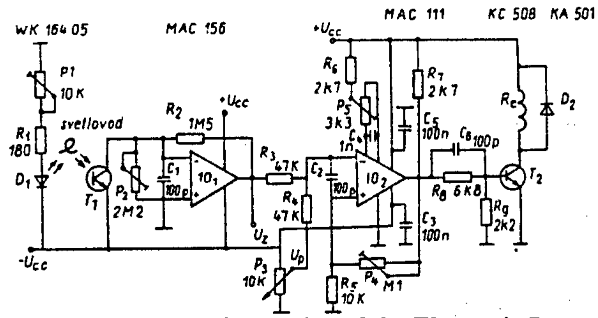


Fig. 4. Diagram of Connection of the Electronic Part.
Key: —1. Waveguide

core. In these, length L must be reduced for the coupling of modes of higher orders. For typical values $n_1 = 1.5$, $\Delta = 0.01$, $a = 0.1$ mm, spatial wavelength of the periodic structure is of the order of millimeter.

Construction

The sensor system recording the intensity of the acting force consists of the sensor proper (device inducing microrefractions of the waveguide by the effect of scanned force) and of an electronic component (source of radiation, radiation detector, signal processing circuit). While designing the structure of the sensor, we proceeded from the demand that it may be used in grippers of industrial robots (for instance, PR 16PR made by the VUKOV in Presov) to obtain precise grip force. That determined the followingstructural requirements: a) sufficient rigidity and sturdiness withregards to the maximum carrying capacity of the terminal of the robot, b) the lowest possible bulk, c) potential simple attachment of the sensor's characteristics according to requirements of intensity of the grip force, d) simple assembly and maintenance.

The structure of the sensor appears in Fig. 3. [6] The sensor consists of basic body 1, to which circuit 2 is attachedwith screws 14, and of sliding body 3. One part of deformation element 4 is attached by insertion in the groove in basic body 1, and the other part in sliding body 3. Both parts of the deformation element are protected against their shifting by means of screws 5. Optical fiber waveguide 6, which is fed between the parts of the deformation element, passes through two fasteners 7. Lead screws 10 are screwed into sliding body 3 and springs 11 are slipped on them. One end of the springs rests on sliding body 3, the other on screws 12 which are fastened to basic body 1 and secured with nuts 13. Nuts 15 and 16 are screwed in the end of leadscrews 10. Spring 17 serves to prevent sliding body 3 from rotating.

Description of the function of the sensor: Basic body 1 of the sensor is fastened with screws inserted through openings 18 in the gripper of the robot in such a way that the scanned force acts perpendicularly to sliding body 3. The fastening of screws 12 limits the stop, thus increasing the maximum force that the may be registered by the sensor. Furthermore, the limiting of the stop protects the waveguide from damage. Nuts 15 and 16 prestress springs 11 for the intensity of scanned forces. The scanned force shifts body 3 towards basic body 1, which produces refraction of the waveguide on the periodic structure of the deformation member. After the load is deposited, spring 8 and gripper 9 tighten the waveguide to its initial position. Basic components of the sensor that essentially determine its characteristics are the fiber optic waveguide and the deformation element.

When selecting the fiber waveguide we had to focus on waveguides with an already connected source and detector of optical radiation,because our experiments with the introduction and transmission of radiation from the waveguide were unsatisfactory. For that reason optical electronic connector WK 164 18 (made by Tesla in Blatna) was used. Model PCS optical fiber waveguide has the following parameters: Diameter of glass core 200 μm, silicone resin coating 380 μm, theoretical numerical aperture 0.4. The coatingis covered with a protective layer of Tefzel, a heat-resistant material, with 600 μm diameter. The periodic structure of the deformation part was made of elements in the shape of semicircle. Because relations stated for the optimum selection of the spatial wavelength of this structure were based on a waveguide without a protective layer, they could serve only as orientation values. We could not remove the protective layer of the waveguide by means available to us because of potential (possibly only microscopic) damage to the waveguide and thus, impairment of its characteristics, particularly its service life. Therefore, several structures of the deformation part had to be tested and verified.

4. The Electronic Part

The electronic component of the system consists of a circuit of the radiation source, a radiation detector, an amplifier, an extension unit of desired parameter, a comparative amplifier and a relay switching circuit. A diagram of their connection appears in Fig. 4.

The purpose of resistance trimer P is to increase the initial output of infrared emitting diode D_1 which is connectedwith the waveguide. Radiation spread by the waveguide is detectedby phototransistor T_1 whose collector is connected to the input of operational amplifier IO_1. Tension U_z scanned from input IO_1 serves to measure the sensor's characteristics. Th required parameter of tension U_p, at which comparative amplifier IO_2 changes the output state, is expanded by resistant potentiometer P_3. Compared tensions U_z and U_p are conducted through transistors R_3 and R_4 to inverting output IO_2. Output IO_2 is conducted to the base of switching transistor T_2, where the LUN 12 type relayis connected to act as ballast of the collector. If tension U_z (corresponding to the scanned force) reaches the level of tension U_p (corresponding to the required parameter of force), the relay interrupts the signal for the movement of the jaws of the gripper of the industrial robot.

5. Results of Experiments

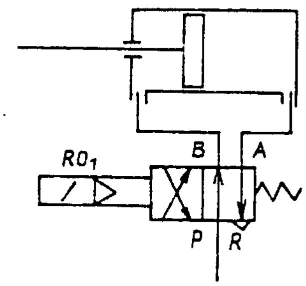
The sensor system was constructed at the Chair for Instrumental andAutomation Technology at the SjF of the Institute of Technology in its Presov branch. Its functions were tested and its characteristics measured with static load: namely, dependenceof output tension U_z on the acting force, or as the case may be, dependence of attenuation A on the acting force. Our experiments tested several variants of the deformation part with different numbers of deformation elements, their radius, spacing and materials from which they were made (rubber, gum, teflon). Fig. 5 presents characteristics for various numbers of deformation elements with constant radius and spacing. The diagram shows changes in the slope of characteristics in dependence on the number of elements, and a change in the area of linearity as well as of the zone of the sensor's "insensitivity." Similar characteristics were obtained for different radii and spacing of the elements and materials used for their production. In the same manner we obtained the characteristics of different types of springs with different expansions of their prestress used in the sensor. Fig. 6 shows some of those characteristics. From the diagram it is evident that the sensor's "work area" may be shifted if springs of different rigidity are selected and if their prestress is increased. If more rigid springs are used, the sensor's "work area" may be shifted to the area of forces higher than those shown in Fig. 6. [Figures 5 and 6 not reproduced]

Obtained characteristics serve for the determination of parameters of the deformation part and for the selection of suitable springs for the required range of scanned forces.

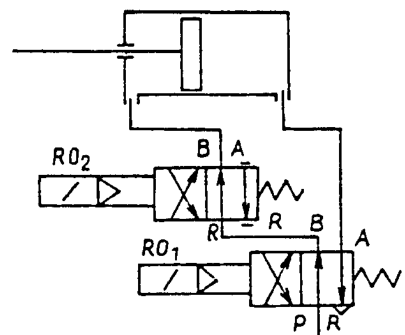
6. Application of the Sensor in the Gripper of Industrial Robots

In order to test practical applications of the sensor, we placed the sensor in the gripper of industrial robot PR 16P to ensure the chosen grip strength. Gripper PR 16P is driven by a push-pull direct-line piston engine controlled by two-position pneumatic FESTO switchboard model MF-4- ⅛ connected as per Fig. 7a. For our purpose a three-position pneumatic switchboard, such as FESTO model MFH-5/3, should be used.However, this particular type was not available and therefore, we used the solution shown in Fig. 7b. We complemented the original connection with an additional two-position FESTO switchboard model MG-4-1/8 which we attached to the plug-in extension of the piston of the pneumatic engine.

The sensor is fastened with two screws to the rigid jaw of the gripper. The object is gripped between the sliding body of the sensor and the movable jaw of the gripper. An electronic plotting circuit is clamped to the body of the robot's terminal arm.[Fig. 8] Electric connection is achieved by leadingin the +/- 15 V tension into the electronic plotting circuit, and + 42 V to feed the electromagnet in the switchboard. For that purpose,



a)



b)

Fig. 7 a). Original Connection of the Pneumatic Circuit of Gripper PR 16P, b) Adapted Connection of the Pneumatic Circuit of Gripper PR 16P.

unconnected conductors in the gripper circuit may be used,and the feeding source may be situated in the box of the robot's control system.

The use of the sensor in pneumatic gripper PR 16P is not entirely appropriate because after some time the force which clamps the object in the gripper cannot be precisely controlled due to the effect of compressibility of the gas medium. However, as regards equipment in the workplace, we accepted this application particularly in order to demonstrate practical applications of the sensor.

7. Conclusion

The sensor system described herein is relatively simple and inexpensive to build. The sensor may also be used to scan pressure and dislocation. Its dimensions may be adjusted accordingto the requirements of its application. It may be presumed that if a fiber optical waveguide without a protective coating is used, the characteristics of the sensor in a larger area would be linear.

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SUPERCONDUCTIVITY

Superconductor R&D at Prague's State Materials Research Institute

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[Article by Eng V. Klabik, ScC, Eng V. Landa, ScC, Eng M. Cadil, Eng V. Plechacek, ScC, and Eng Z. Trejbalova, State Materials Research Institute in Prague: "Superconductor R&D in the State Materials Research Institute in Prague"]

[Text]The authors present a review of programs conducted in the SVUM [State Materials Research Institute] in the field of superconductors, research of superconductors for alternating applications, conductors for direct-current application, parameters of developed fiber superconductors and furthermore, introduction of superconductors in the production of the Kablo company in Kladno.

1. Introduction

Superconductors with high critical parameters, i.e., high critical temperature T_c, current density J_c, and high induction of critical magnetic field B_{c2}, are the basic materials that facilitate practical applications of superconductivity. Although a recent discovery of high-temperature superconductivity suggests further perspectives in this area, at present fiber conductors made of alloy of NbTi, and to a lesser extent fiber or laminated conductors with A 15 structure (intermetallic phases Nb_3SN, V_3Ga or Nb_3Ge) still remain the most important and widespread superconductive materials. In the period from 1957 to 1964 the main types of superconductors with high critical parameters (Nb_3SN, NbZr, V_3Ga, NbTi) were discovered; since the 1960's they led to an intensive development of technology of production of applicable conductors suitable for the construction of superconductive magnets and in general, for practical applications of superconductivity.

In the 1960's research of superconductance in the CSSR started successfully particularly with the programs of the

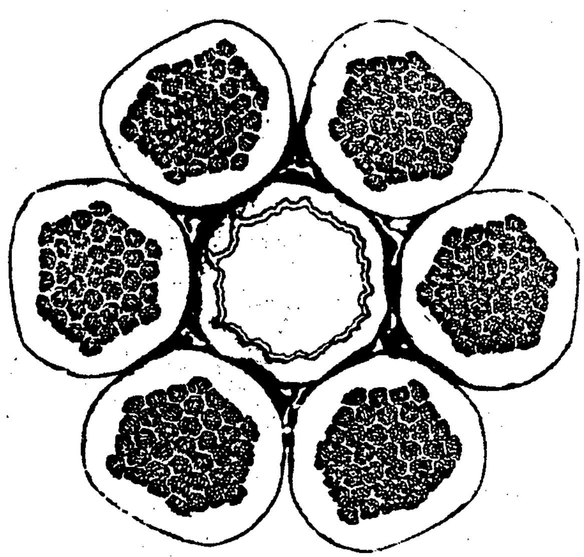

Fig.1. Cable made of fiber superconductor Nb_3Sn. Six external veins from unstabilized 703- fiber conductor, the core of copper lined with a tantalum barrier.

Physics Institute at the CSAV [Czechoslovak Academy of Sciences] (formerly UJV [Nuclear Research Institute] and UJF [Institute of Nuclear Physics] of the CSAV in Rez near Prague) and of the Electrotechnical Institute of the SAV [Slovak Academy of Sciences] in Bratislava. Among the CEMA countries the CSSR became the USSR's main partner in basic and applied R&D of the applications of superconductivity—naturally, also because additional institutes gradually began to join and become involved both in the research and production areas. The SVUM contributed to this trend with R&D of the production technology of fiber superconductors, with practical design of prototypes for individual types, with control and study of their characteristics.

Review of the SVUM's Works in R&D of Superconductors

In view of the institute's focus and technological equipment of particularly for the field of vacuum metallurgy, our first works in the 1960's involved the preparation and processing of superconductive alloys of the then up-to-date Nb-Zr system. Unlike alloys with high Nb contents (most frequently 75 mass. %) developed and used in the West, we were focusing on an alloy of an opposite composition—ZrNb25. A suitable combination of thermal and mechanical processing helped even this less expensive alloy achieve comparable critical current values [1, 2]. Studies of the mechanism of the creation and function of phase precipitates as effective pinning centers provided the basis for similar works with alloys of the Nb-Ti system which in agreement with the worldwide trend became the basic material for the development and production of the type of superconductors which is by far the most widespread and to this day the most important. With the transition to the study of the NbTi superconductors, our technological furnishings

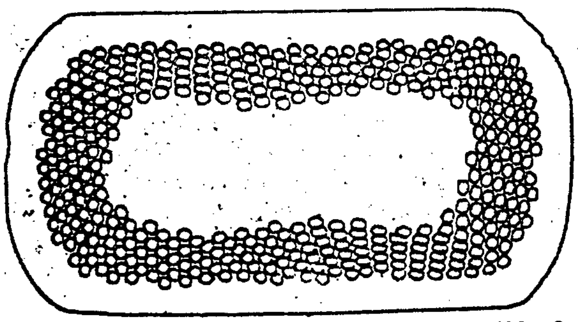

Fig. 2. Cryogenically stabilized conductor type 402 - 2 x 3.5/6. 402 NbTi fibers in copper matrix 2 x 3.5 mm, ratio Cu:NbTi = 6.

were also expanded. Gradually we learned to master the R&D of the entire metallurgical processing of fiber superconductors: namely, in addition to our vacuum equipment and primary metallurgical hot and cold processing, also extrusion pressing and subsequent coarse and fine drawing. For the study of important physical properties, especially critical parameters, it was necessary to build a cryogenic laboratory. No less important for comprehensive research was our cooperation with other SVUM laboratories, which provided opportunities for studies and control of chemical composition, mechanical characteristics, structural analysis and metallography of output materials, semifinished and final products.

Approximately since the late 1960s the SVUM has been an important R&D workplace for fiber superconductors and as such, it has been continuously involved in research programs of superconductive materials and technical applications of superconductivity, coordinated by the Electrotechnical Institute of the CEFV at the SAV in Bratislava. The first significant result of our research program was the development of two variants of superconductive alloy NbTi with 40 and 50 mass. % Nb, complemented by advantageous values J_c in lower and higher inductions of the magnetic field. In their day—in the early 1970's—the critical parameters of these alloys were comparable with the products of the foremost world manufacturers, for example the British IMI, the French Thomson, or the American Supercon.[3, 4, 5]

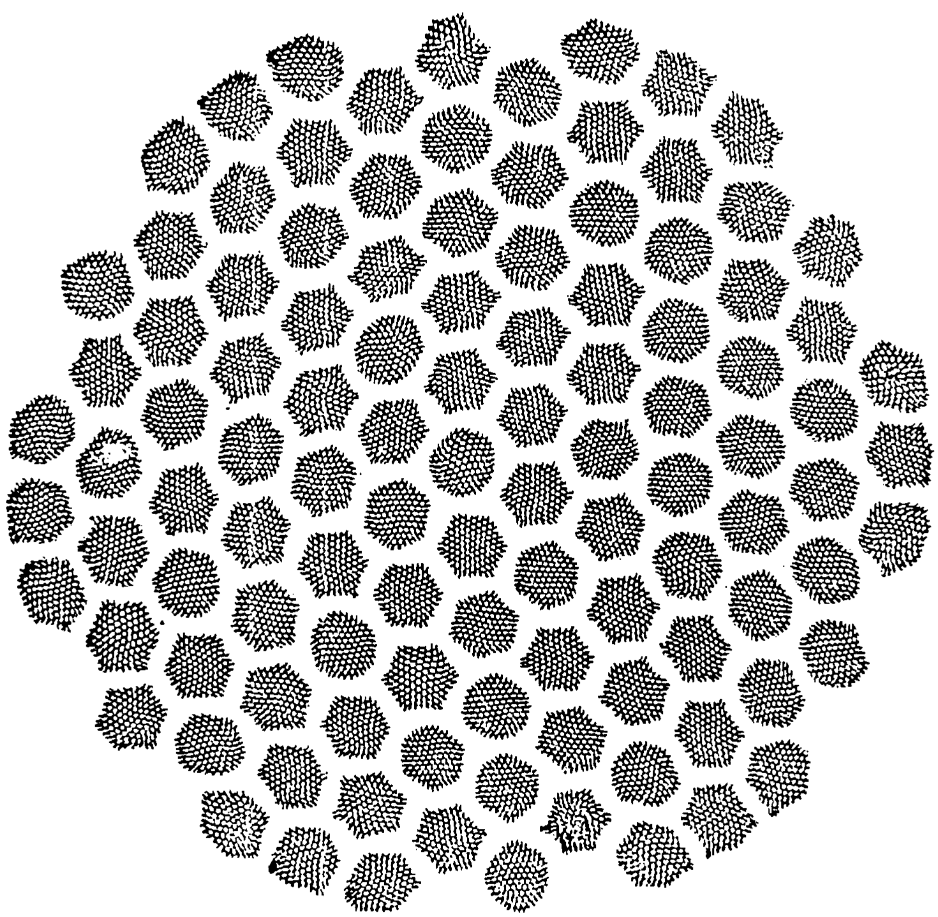

Fig. 3. Conductor for alternate applications. 11,821 NbTi fibers in resistant matrix CuNI20. Diameter of the conductor 0.26 mm; diameter of the fibers approximately 1 m.

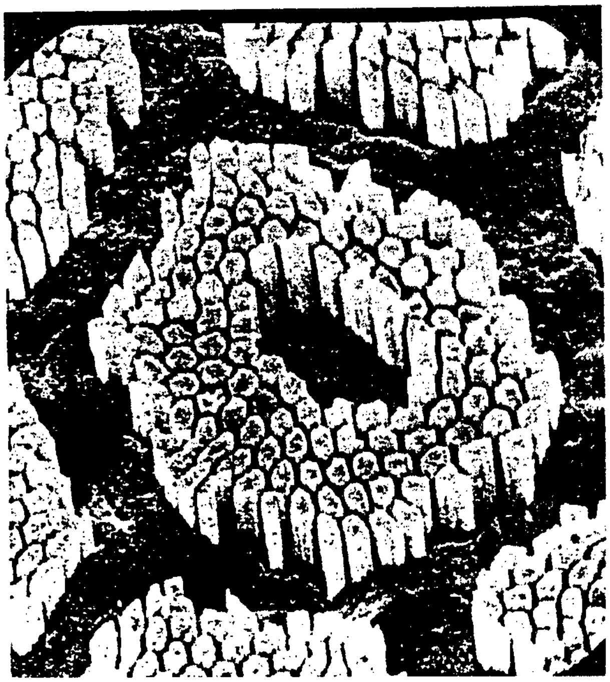

Fig. 4. Detail of NbTi fibers in a conductor for alternate applications. Combined matrix CuNi + Cu; copper is built in the middle of groups of fibers.

As concerns the production technology of fiber superconductors, the technology of production of single-fiber and multifiber [10, 36, 61] was developed. After functional characteristics of the developed and manufactured superconductors were confirmed, a series of superconductive magnets were produced; because of their good properties and advantageous parameters they are still used for research and other purposes. For instance, a magnet designed and produced in cooperation with the EU [Power Research Institute] of the SAV in Bratislava as long ago as in 1972 consists of three telescopic sections, in which magnetic induction generated in the inner section amounted to 9.25 T and in the clearance, obtained by means of ferromagnetic concentrators, to 2 mm 11T.[6, 7, 8, 9] The SVUM also exerted significant influence on the development of fiber superconductors on the basis of the intermetallic phase of Nb_3Sn, and is one of two research institutes in the CSSR preparing this material also for practical application. Technology of production applies the so called bronze method: in the tin bronze matrix niobium rods are formed by repeated hot extrusion and drawing until they acquire their final shape, which is bronze wire containing hundreds and even thousands niobium fibers whose diameters are of the micron order. This semi- finished conductor product is subjected to the final diffusive reactive annealing; only during that process the actual superconductive Nb_3Sn phase develops by reaction with the tin diffused from the matrix on the surface of the niobium fibers; naturally, because this phase is very fragile, this occurs only after the conductor is covered with insulating material and twisted into the shape of appropriate magnet.

In particular, the SVUM thoroughly studied technical conditions for the production and processing of a suitable type of matrix alloy CuSn12 characterized by great plasticity and furthermore, determined conditions for reactive annealing between individual stages and in the final stage, which are most favorable for the production of conductors with high critical current density. Production technology for several variants of the conductors—namely, with 703, 1,615 and 3,145 fibers—was developed in the simplest monolithic unstabilized version.[10, 11, 12, 13] For more exacting applications, where conductors must be stabilized by a proportion of highly conductive pure copper in the matrix, a monolithic type of conductor with an anti-diffusive tantalum barrier was developed, and furthermore, a highly effective method of preparation of seven-core cables.[14, 15]

For stabilization they contain one or several cores made of stabilized copper (with tantalum barrier) and are able to conduct currents several times higher than monolithic conductors. Moreover, researchers tested a sophisticated variant of the conductor with tube-shaped niobium fibers inside which are parts of stabilizing copper.[16, 17].

3. Research of Superconductors for Alternate Applications

Special structures of NbTi fiber superconductors may considerably reduce losses in operations in pulsar regimes and in alternate frequencies up to 50 Hz. A decisive part of such adjustments concerns division of the superconductor proper into numerous fibers with micron diameters, in markedly increased resistivity of the matrix of the conductor (with the use of resistant alloy Cu-Ni), and in the stranding and transposition of superconductive fibers.

Many physical-metallurgical and technological problems may occur during R&D of technology of production of these conductors. Of major importance among them are purity, homogeneity and good malleability of all materials in the composition of the conductor. No less important task is to determine and exactly follow the conditions for all technological operations. In particular, temperatures of extrusion and annealing between individual stages are decisive because fragile phases (Ti_2Cu or TiNbCu), which may form on the surface of the NbTi fibers, produce irregularities during the drawing process, which may cause breakage of the fine fibers.

The problem of the optimum thermal regime is connected with the possibility of achieving high critical current density of the superconductors: the optimum structure and concentration of the pinning centers in superconductors are obtained during the process of precipitation annealing at a 375° temperature over a period of several days hours with subsequent final cold deformation.[18] Table 1 presents a chart of a developed complete technological process of production of fiber superconductors with micron fibers. The whole process

is divided into several groups of operations which form units characterized by certain semifinished, or as the case may be, final products. Thermionically melted niobium, iodide titanium, copper of OFHC quality, and alloy CuNi20 melted down from that copper and of Monde nickel must be used as the initial raw material.

Table I. Chart of the Technological Production Process of Fiber NbTi Superconductors with CuNi or Cu + CuNi Matrix

Group of Operations	Individual Operations	Initial Raw Material - Final Product
01 Production of NbTi rod	05 Production of fusible electrode	Niobium, titanium - chips or strands
	10 1. Melting in vacuum arc furnace	
	15 Cutting of ingot into segments	
	20 Cold rolling of segments	
	25 Assembly of rolled product in fusible electrode	
	Second melting	
	35 Cutting of ingot into segments	
	40 Forging of the rod	
	45 Annealing and hardening	
	50 Turning to finish the surface	Rod-shaped semifinished product NbTi50
02 Production of single-fiber composite of CuNi/NbTi (1. coupling)	05 Production of CuNi tube	Cu casting
	10 Forging of CuNi tube on NbTi rod	Product of operation 01.45 and 02.05
	15 Rotary forging by gradual reduction	
	Calibration by drawing into hexagon	
	25 Cutting into rods	Single-fiber semifinished product CuNi/1NbTi
03 Production of composite semifinished product CuNi/nNbTi; n - of 10^2 order (second coupling)	05 Production of CuNi sheet	CuNi casting or tube
	10 Forging of CuNi tube in NbTi rod	Product of operations 02.25 and 03.05
	15 Vacuum patch welding	
	20 Hot extrusion	
	25 Drawing in tube-drawing mill	
	30 Calibration into hexagon	
	35 Cutting into rods	Composite multifiber semifinished product CuNi/nNbTi
04 Production of multifiber semifinished product CuNi/nNbTi; n-order 10^3 - 10^4	05 Production of CuNi sheath	CuNi casting or pipe
	10 Assembly of the composite	Products of process 03.35 and 04.05, Cu semifinished products
	15 Vacuum patch welding	
	20 Hot extrusion	
	25 Drawing	
	30 Precipitation annealing	
	35 Finishing drawing	
	40 Twisting	
	45 Coating with insulating layer	Multifiber superconductive conductor

Basic parameters of three variants of conductors are presented in Table II. Two variants (a, c) have portions of highly conductive copper built into the resistant matrix for stabilization and reduction of resistivity in the longitunidal direction. Because of high technological demands on them, only few world manufacturers of superconductors (AIRCO Superconductor, Alsthom-Atlantique, Showa Electric Wire Cable Co) produce this type of conductors.[19, 20] In terms of their parameters, conductors of our manufacture are comparable to commercial products.

NbTi Conductors for Direct-Current Application and the Launching of Their Production

Main operations of the technological process of production of simple types of NbTi superconductors developed in the SVUM in Prague are outlined in Tab. III.[13, 21, 22] Because during the production the superconductive alloy is subjected to total cold deformation up to 99.99%, it must be very pure, homogenous and malleable. During groups of operations in the production of fusible electrode, first and second fusion, and of primary shaping, contamination of the superconductive alloy and formation of flaws (non-homogeneity, development of gas and oxides, inclusions, etc) must be prevented. Even if very pure initial raw materials are used, these requirements may be met only with vacuum melting and remelting, rotary swaging, hot extrusion and cold shaping.

Table II. Parameters of Developed Superconductors for Alternate Applications

Superconductor - NbTi50
Matrix - CuNi20
Diameter of conductor D = 0.2 - 0.3 mm
Diameter of fibers d = 0.8 - 1.4 μm
Pitch of the twist l_p (period)/= 10D
Number of fibers -7, 128 (a)/11, 21 (b)/17, 424 (c)
Filling λ_{NbTi} - 15 - 22 %
λ_{Cu} - 5 - 8 %
Critical current value Jc(1 T) = 6 GA.m-2
Jc(5 T) = 1.8 GA.m^{-2}

During the process of cold shaping of the conductor great density, which develops as a result of dislocations, determines the achievement of high critical current density J^c. During the precipitation hot processing (PTZ), precipitation of the nonsuperconductive phase takes place. The precipitates and the dislocation structure find their application especially in the so called pinning and help achieve a high value of J_c. Already during their development the SVUM produced NbTi superconductors NbTi which were introduced in various magnetic systems in workplaces in the CSSR. In addition to the above- mentioned tri-sectional magnet, in the EU CEFV of the SAV in Bratislava, they were used in the production of laboratory magnets, models of separators and the NMR spectroscope; in the UPT of the CSAV in Brno they were used for the production of two superconductive magnets of NMR spectrometers with top parameters; the Department of Mathematics and Physics of Charles University in Prague and the Physics Institute of the CSAV in Rez designed and produced superconductive magnets for scientific purposes (such as vibration magnetometer, neutron polarimeter, etc). Current and future assortments of NbTi superconductors are determined by their potential application in Czechoslovak economy. Single-fiber conductors designated as 1-40/25 and 1-40/20 are earmarked for NMR spectrometers. Kablo of Kladno supplies conductors to Tesla in Brno which develops and manufactures these spectrometers. Fiber type 402 with designation 402-2x3.5/6 which is used in ETZ SKODA in Plzen is earmarked for separators and rotary machinery. Conductors of the 24-200/6.5 type are designated mainly for tomographs. Fiber type 132 with designation 132-90/4.5 was developed for the needs of EU CEFV of the SAV in Bratislava.

Conclusion

Superconductivity is applied at an increasing rate also outside scientific and research institutes. However, its application on the industrial scale determines operations introduced in the production enterprise. Most operations of technological processes require special machinery and equipment and laboratory testing during the production process. Therefore, industrial production was successfully launched on the basis of cooperation of various organizations: the SVUM in Prague has the task of melting of the superconductive NbTi alloy, preparing the semi- finished Cu/NbTi products, and coordinating general operations; the Poldi SONP [Steel Works, National Enterprise] in Kladno produces semi-finished rod-shaped NbTi products; the Kovohute [Metallurgical Works] in Celakovice extrudes semi-finished NbTi products and produces semi-finished Cu products; the Kablo in Kladno processes conductors of less than 15 mm in diameter. The Kablo in Kladno is also the final manufacturer (supplier) of NbTi fiber semiconductors. Since 1984 it has financed the SVUM research in which that enterprise invested until 1987 Kcs 5 million and furthermore, with its own hard currency funds it procured the essential raw material - niobium. Since 1988 the research has been funded with the resources of the ZSE [High- Voltage Electrical Engineering Plants] state enterprise in Prague.[23] The Kablo in Kladno incorporated in its program the superconductors developed in the SVUM. According to consumers' orders, it manufactures main models of those superconductors. It may be presumed that joint efforts of the experts in the research and production base will succeed in ensuring sufficient supplies of quality superconductors, which will make it possible for the CSSR industry to utilize superconductivity.

Table III. Technological Process of Production of NbTi Fiber Superconductors

Name of Groups of Operations	Main Operations	Final Product
Production of NbTi fusible electrode	Nb planing	NbTi ingot of first melting
	Second melting	NbTi ingot of second melting
Primary shaping	Rotary hot forging	NbTi rod of 20-30 mm diameter
	Rotary cold forging	NbTi rod with 7-11 mm diameter
	Homogenizing (diffusion) annealing of NbTi semifinished product	Homogenous NbTi semifinished product
Secondary shaping	a)Sheathing of the NbTi core with Cu by stud driving of the drawing of the composite	Single-fiber Cu/NbTi semifinished product
	b) Coupling of Cu/NbTi dimension stock in Cu tube—drawing of complex composite	Multifiber Cu/NbTi semifinished product coupled by drawing
	c) Coupling of NbTi dimension stock in Cu matrix—hot extrusion—drawing of complex composite	Multifiber Cu/NbTi semifinished products coupled by extrusion
	d) Coupling of Cu/NbTi dimension stock in Cu matrix—hot extrusion—drawing of complex composite	Multifiber semifinished Cu/NbTi product
	PTZ	
	Drawing of complex composite to final dimension, twisting	
	Final annealing, polishing	Superconductive conductor NbTi

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TELECOMMUNICATIONS R&D

Modernization of Telecommunications Network in Slovakia

90CW0179A Prague TELEKOMUNIKACE in Slovak No 12, Dec 89 pp 177-178

[Article by Eng Pavol Medved, Sprojprojekt, Bratislava]

[Text] **The worked-out "Concept for the Development of Communications Through the Year 2005" contains specific requirements and goals for the development of individual networks, even those involved in telecommunications. The basic goal for the upcoming time frame is the elimination of disproportions between requirements and capacities of networks, accompanied by increased operational quality and reliability. In conjunction with this goal, greater flexibility and expansion of the types of services offered is called for. The acceleration of "telephonization" continues to be a priority developmental program, involving the progressive digitization of telephone and telegraph networks, accompanied by the development of additional services (data service, radiotelephony, etc.). The target task, supported for the period after 1995, is to be the integration of the various networks and services.**

At the beginning of this year (1989), we were, for the first time, officially familiarized with the view that the yardstick for the quality of our work was the satisfaction of the needs of the public and the attainment of a level commensurate with that of the developed nations and not only the safeguarding and fulfillment of plan indicators. The safeguarding of this articulated goal would have proceeded in a more dynamic manner had it been strengthened by a system of material incentives.

The purpose of this article is to familiarize readers with the basic data regarding the requirements for quantitative development and to point out the procedure which will be required to support the development of the individual networks, as well as to indicate the means which we expect to use for the creation or modernization of individual telecommunications networks.

The concept of modernizing telecommunications networks can include, in a very broad extent, the problem as it is connected with those criteria which we set for ourselves for solving this problem. I have aimed the article at familiarizing readers with the goals and problems, which are topical at this time, a time which can be defined as the period of preparation for the digitization and integration of networks and services in telecommunications.

Toward the end of the 1st half of 1989, more than 1,179,000 telephone stations were in operation in Slovakia, including 655,000 main stations, of which 476,000 were located in apartment units (subscriber stations).

Telephone density had reached a level of 22.16 stations per 100 inhabitants and the number of subscriber stations had attained a level of 12.31 per 100 inhabitants. The number of telephones in apartments is 26.84 stations per 100 apartments in Slovakia and 59.1 stations per 100 apartments in Bratislava alone.

Fulfillment of the targets set for the 8th Five-Year Plan for telephonization will become possible at the beginning of next year (1990), however, the number of pending applications for telephones is showing a growing trend. The attainment of the required level of telephonization is not responding to the needs of socioeconomic development of society and it is therefore necessary to speed up the pace for the capacity and quality development of the telephone at work.

For the time period under consideration, the development of the individual networks is being anticipated on the basis of the evaluation of social needs to the extent listed in the accompanying table.

Item	1995	2000	2005
Total number of telephone stations (000)	1,666	2,480	3,342
Main telephone stations (000)	974	1,565	2,314
Private subscriber stations in apartments (000	716	1,200	1,730
Apartment units equipped with telephones (%)	38.6	59.7	80.0
Data stations outside of Public Data Service	3,800	6,254	12,500
Data stations within Public Data Service	600	4,000	8,000
Teletype stations	4,400	5,600	6,300
Teletex stations	600	1,600	4,000
Telefax stations	800	2,300	5,000
Videotex stations	300	2,300	6,900
Radiotelephone stations in public network	80	6,000	10,000

As long as the development of individual networks will be supported on a one-time basis at innovative intervals, it is necessary to realize that, in order to fulfill the demanding goals, a certain pace must be maintained in the development of the telephone network. It will be necessary to speed up the current pace to assure an increment of a minimum of 80,000 telephone stations per year during the 9th Five-Year Plan and more than 160,000 telephone stations per year during the 10th Five-Year Plan.

Long-distance telephone operations at the highest network level are secured by seven transit telephone centrals with a cumulative capacity of up to 30,600 branch stations. By the end of the 8th Five-Year Plan, and within the framework of ongoing expansion, it is planned to activate an additional 2,600 branch stations and in the 9th Five-Year Plan expansion is planned to include an additional 6,800 branch stations. These tasks are intended to complete the capacity expansion of the communications portion of the network by the addition of second- and 2.5-generation systems having a cumulative capacity of 40,000 branch stations. Additional development must be oriented exclusively to the installation of digital systems.

At the junction level outside of the UTO involving transit centrals, intercity centrals are equipped with basic types of second-generation systems. Toward the end of the 8th Five-Year Plan, the capacity of type MK611 centrals will exceed 10,000 stations and the number of junction centrals equipped with asynchronous devices will exceed 50 percent of the overall number of telephone centrals in Slovakia. What is important is the anticipated overall result—when the capacity of asynchronous centrals exceeds 80 percent of the required number of connected buildings required to conduct long-distance operations, something which has a decisive influence upon the operational reliability of the entire long-distance network.

In the 1st half of 1989, the teletype network operated 3,770 stations. A topical event in recent months was the modernization and capacity expansion of the network. For purposes of modernizing, renewing, and expanding the existing centrals operating first-generation equipment, use was made of the modern, operationally reliable digital communications system (AXB20) intended for telegraph networks and transmitting data at a modulation velocity of 300 bits/sec. By using concentrators and multiplexers, the optimum method for covering the capacity requirements and distribution of participants in the network were achieved. The integrated telegraph central for telex and public telegraph services in Bratislava handles its operations by using concentrators at Nitra, Zilina, Banska Bystrica, Kosice, Presov, and at Ceske Budejovice, with 26 multiplexers from the appropriate locations of telephone junction buildings being either directly connected or connected via concentrators. This significant modernization step, which resulted in a mixed network at a very good level, needs to be augmented during the 2d half of the 9th Five-Year Plan by finishing renewal operations or possibly by the additional expansion of a substantial part of the network through the addition of the AXB20 system. Within the integrated network, this would lead to the unification of the type of communications system in operation which would, primarily, render the method of managing operations and maintenance more effective and more rational.

In recent years, the transmission of data has become the most dynamic telecommunications service. The annual growth in the number of stations has attained the level of 20 percent and it is anticipated that this pace will be maintained even in the 9th Five-Year Plan. Currently, some 701 stations are in operation. The primary task in expanding telecommunications involves the initiation of more rapid preparations for the development of the public data transmission network so that, by the beginning of the 9th Five-Year Plan, construction could begin and put us in a position of being able to provide timely

services of the required quality. The importance of accelerated procedures is also supported by the fact that the public data network is also the transmission medium for additional telematic services.

Modern services introduced during the course of last year include the facsimile transmission of reports, using the telephone network. Seven stations in the Postfax system were in operation in October 1989, and 170 private subscribers used the fax system. By the end of the year, it can be anticipated that there will be 250 operating stations. Of the overall volume of data transmitted, public communications stations handle only a very small quantity.

The inauguration of digitization, which facilitates the integration of transmission and communications equipment in telecommunications, can be characterized as being very slow. With respect to imported communications systems, a demanding selection is under way, but continuation of importing the E10A system does not reflect current requirements. The requirements for operation and further expansion of the network are met only by systems which can collaborate within the network at least with a 2B + D basic interface.

Considerations being given to the mass development of networks with the use of digital program systems until after 1995 means falling behind even with respect to countries showing average development. The primary and decisive factor is the ability to assure delivery of equipment in the necessary quantities, quality, within the required deadlines, and of the required assortment. The digital systems which have thus far been used within the telecommunications networks demonstrate a very good level of operational reliability.

The specialized and organizational capabilities of our employees with respect to mastering the investment process and the introduction of modern digital systems into operation are at the required level and initiative and commitment, however, are little utilized as a result of shortcomings in material-technical support and because of an obsolete and inflexible wage system.

In addition to the above goals, we consider it important to focus attention on a little-followed area having to do with the tasks of modernizing and developing the telecommunications networks. We can call it the area of algorithmic solutions. The training and instruction of employees in this area is not well-developed in our country. For example, we can currently break down the local telephone network into five parts, each one of which represents a definable whole:

- subscriber (terminal) equipment,
- subscriber telephone network,
- telephone central equipment,
- communications telephone network,
- facilities for technological equipment.

In solving the modernization and expansion of the telephone network in the previous time frame, we generally copied the existing network configuration overall at a higher quality level. Today, we must solve the problem more comprehensively, even though it is more demanding and less comfortable, by applying high-efficiency computer methods in seeking optimum solutions—a new network configuration. This is true with respect to solving the network for large city agglomerations, no longer only for decentralized, but for local networks as well. For comparison, we can cite the problems involved in the solution of large city telephone networks—increased telephone density in existing built-up areas and the connection of stations from additional peripheral parts of the city.

The first solution is possible through the use of classic algorithmic systems—expansion or construction of new facilities, expansion (new construction) of central offices, new communications lines, and a new local telephone network.

The second solution would be a proposal for the establishment of digital central offices for new parts of the city as well as for increased telephone density in existing built-up areas. A contribution would primarily be the utilization of digital transmission in communications circuits, a lowered requirement for new construction of facilities, conservation of energy, and, in mature countries, also lower cost for a digital hookup at the central office, in comparison with a second-generation system.

A third solution is a maximally reworked creation of the network (ATU regions) of digital central offices in combination with remotely located subscriber group levels, distributed throughout the network, utilizing digital concentrators. In contrast to the second solution, this solution not only results in digital transmission over communications circuits, but also within the subscriber network and the consistent solution will result in maximum speedup for subscriber connections.

Given our capability to compile a program for the optimum dimensioning of a network and for utilizing computer systems for this purpose, it is possible to attain an optimum and efficiently doable proposal for a telephone network. Currently, we have begun to solve a task postulated in this manner for the Bratislava network by utilizing data provided by the chief architect regarding the intentions for utilizing and occupying the city area in accordance with urbanistic districts.

With such an approach, it is simultaneously possible to achieve a high degree of utilization with respect to the connected points of the central office, the city telephone service, and communications circuits because expansion can be accomplished using a greater quantity of smaller modules with time distribution (USS + street cabling + a circuit expansion module).

A similar philosophy can be applied also in the creation of the network at the UTO by finding a solution for the entire UTO at once.

Currently, we are solving two large-city networks (Kosice and Bratislava) by the placement of individual contracts. In Kosice, from the standpoint of current supplier possibilities, the first type of solution is being applied. In Bratislava, the realizational phase of establishing the first digital local telephone central was, unfortunately, initiated only with the involvement of a single subscriber group stage (satellite). This problem received attention in the subsequent investment stage and the third type of expansion is being applied, which includes the distribution of subscriber groupings in the network.

I consider the intensive initiation of processing involving technical proposals and organizational procedures dealing with the development of digital networks, which should be assured during the 9th Five-Year Plan, to be a pressing need. For comparison purposes, I cite the fact that, by the end of the 8th Five-Year Plan, 10 European countries have already initiated test operations of the ISDN system.

The result of development, which has been long ongoing, is the fact that the Directorate of Communications operates several types of different networks and that subscribers need several attachment circuits for the different types of terminal equipment. Currently, high-efficiency computer equipment is being introduced into operating processes at a rapid pace, which creates pressure upon the creation of additional types of networks having demanding parameters. With respect to telecommunications networks, the demand for quality is rising, they are being integrated and are being handled with the use of digital devices. The current types of services involve the telephone network, the integrated teletype network, the data transmission network, and the personal network (special communications, disaster communications, telemetry, etc.).

The task, then, is to establish a digital network (ISDN) which would facilitate the connection of terminal equipment and which would provide a broad array of services. The devices cooperate with the digital network through their defined standard interfaces.

For purposes of transmitting information in ISDN networks, the CCITT has designated various transmission channels. Voice signals are transmitted over so-called B channels at a velocity of 64 kbits/sec, which is comparable to the current telephone system with pulse-code modulation.

However, this channel can also transmit, using the same velocity, data or it can also transmit image information, provided it does not change too rapidly. The D channel is designated for the transmission of management information (assures connection and breaking the connection, channels data transmitted via the B channels, etc.). It has a transmission speed of 16 kbits/sec, depending on user choice (so-called basic or primary type of interface).

Basic Interface

The basic interface has two B channels and one D channel operating at a velocity of 16 kbits/sec and is designated 2B + D. One of the B channels can be used to transmit acoustic signals; another for the transmission of data. A time multiplex makes it possible for the user to utilize both channels simultaneously with the same connection. It is anticipated that the 2B + D channels will primarily serve individual local users.

The Primary Interface

The primary interface is suitable for connecting larger institutions which have their own switchboards. It is currently used in two versions:

- at a frequency of 1.544 Mbits/sec, adequate for a 23B + D configuration (it is used in North America and in Japan);
- at a frequency of 2.084 Mbits/sec, facilitating the operation of 30 B channels and 1 D channel (it is used in the other countries).

In both cases, the D channel has a velocity of 64 kbits/sec.

New types of terminal equipment, whether it involves newly designed digital telephone instruments or smart terminals and work stations are to be equipped with appropriate standard interfaces, either of the basic type or of the primary type.

An overview of the types of channels follows:

B—64-kbits/sec channel (PCM, packet data),

D—16- or 64-kbits/sec channel (signals special information and packet data),

HO—a channel with 384 kbits/sec,

H 11—a channel with 1,536 kbits/sec,

H 12—a channel with 1,920 kbits/sec.

The H channels are intended for the high-speed transmission of data and video.

The social need for the intensive creation of digital networks is pressing and yet the realizational preparations are not proceeding in harmony with this need. The creation of adequate capacities in the networks is not realistic in terms of the timing required. Therefore, upon entering the 9th Five-Year Plan we must develop maximum effort and endeavor in creating the organizational and motivational prerequisites so that at least the human factor would not constitute any obstacles to the further development of telecommunications. All those who place profession above employment in this endeavor should be given full support.

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